

Groundwater LTM and MNA

Groundwater is sampled through the BGMP. At Parcel B-1, groundwater monitoring was initiated in 2004 and currently consists of sampling six groundwater monitoring wells screened in the A-aquifer for VOCs and metals, as well as MNA parameters to evaluate and track natural attenuation processes. The BGMP is routinely optimized based on monitoring data. The sampling protocol was amended so that monitoring well IR20MW17A, which was only sampled for vinyl chloride (VC), was revised to include 1,2-dichloroethene and TCE for consistency in monitoring the VOC plume at IR-10 (TRBW, 2020a). Annual and semiannual groundwater monitoring reports from 2019 through 2021 were also reviewed (TRBW, 2020b; 2020c, 2022a, 2022b, 2023). **Appendix E** presents exceedances of RGs (identified as project action limits [PALs]) from 2019, 2020, 2021, and 2022.

One VOC (VC) exceeded its RG in multiple wells for all sampling events from 2019 to 2022. One additional VOC (TCE) exceeded its RG in one well during the March 2021 sampling event but did not exceed before or after that event. Exceedances of RGs from the 2022 BGMP sampling are shown on **Figure 3-5**. Concentrations of TCE and VC were within historical ranges for all monitoring wells in Parcel B-1 (TRBW, 2023).

Radiological Surveys and Remediation

ROCs suspected to be present at Parcel B include cobalt-60 (Co-60), strontium-90 (Sr-90), cesium-137 (Cs-137), radium-226 (Ra-226), and plutonium-239 (Pu-239). The Navy conducted TCRA at Parcel B (both Parcels B-1 and B-2) to address potential radioactive contamination in storm drains and sanitary sewer lines and radiologically impacted structures. In total, 65,184 cubic yards of soil was excavated during removal of 24,826 linear feet of sanitary sewer and storm drain lines. Approximately 6,641 cubic yards of soil was disposed of offsite as LLRW based on surface scan and analytical laboratory results. Additionally, final status surveys (FSSs) were performed at four radiologically impacted buildings (103, 113, 113A, and 146) and three former building sites (114, 142, and 157) (TtEC, 2012).

TCRA data were reviewed as described in **Section 1.4.3**, and radiological retesting, including sampling and surveys of soils previously investigated during sanitary sewer line storm drain removal and resurvey of impacted buildings and former building sites, is currently being conducted to determine if current site conditions are compliant with the RAOs.

Institutional Controls

The land use and activity restrictions are described in the LUC RD Report (ChaduxTt, 2011a). As described in the Amended ROD (Navy, 2009), the entire area of Parcel B-1 is subject to ICs. A portion of Parcel B-1 is also subject to ICs related to VOC vapors (**Figure 3-2**). The ARICs related to VOC vapors will be redefined after the IR-10 RA is complete and documented in the RAWP (Insight-ESI, 2023). **Table 1-3** summarizes the IC performance objectives to be implemented through land use restrictions for the site.

3.4.2.2 Remedy Operations and Maintenance

Ongoing O&M at Parcel B-1 includes maintaining the integrity of the soil cover, revetment, and asphalt cover, and IC inspections. The inspection and maintenance requirements for the remedy are described in the Final O&M Plan (ERRG, 2016). AOMSRs are prepared to summarize inspections and maintenance performed and to document the effectiveness of the remedy components. AOMSRs from 2019, 2020, 2021, and 2022 were reviewed (Innovex-ERRG Joint Venture, 2020, 2021a; APTIM, 2022, 2023).

Durable Cover Maintenance

The shoreline revetment was determined to be in good condition. No signs of vegetation or trash, pests, excessive vehicle traffic, settlement or movement, improper placement of fabric, vandalism or theft, cover soil overtopping, wave overtopping, or scouring were observed. The Navy is currently conducting a shoreline assessment study to identify and recommend repairs and/or stabilization of structures and shoreline.

Annual inspections found the soil cover to be in good condition, with no signs of settling, slope failure, cracking, soil movement, or erosion. Minor evidence of burrowing animals was noted in one area of Parcel B-1 in 2021; however, no corrective actions were recommended. Drainage swales within the soil cover were also found to be in good condition. Vegetation growth was well established over the soil cover, with no bare areas observed. Vegetation on the soil cover was mowed in August 2019 and August 2020. No signs of excessive vehicle traffic on the cover were observed.

The asphalt cover was generally found to be in good condition, except for minor sinkholes on the northern side of Parcel B-1 near the former dry dock observed during the September 2021 inspection, which were repaired. Vegetation observed growing through cracks in the asphalt pavement cover was removed in October 2020 and December 2021.

Building foundations were found to be in good condition, with no new or expanding cracking. Generally, swales and check dams were clean and intact; however, minor coating of sediment was noted and removed in the drainage swale northwest of Building 146. Signs of excessive vehicle traffic (such as minor cracking in the asphalt surface) within the drainage swale southwest of Building 123 prompted the construction of a vehicle crossing using rock and steel plates in March 2018. The vehicle crossing was observed to be intact and in good condition. However, access to Parcel B-1 should continue to be restricted to limit degradation to the swale and associated asphalt cover.

The 2019 survey data for the settlement monuments indicated Monument SM-1 in Parcel B-1 showed negligible change in elevation (that is, less than 0.1 foot of settlement) since surveyed in 2018. Based on the negligible change (less than 0.1 foot) in historical survey monument elevations, the next round of settlement monument surveys will be in 2024.

Institutional Controls Compliance

ICs are inspected annually, and no deficiencies or inconsistent uses were observed during the review. General site conditions were determined to be good. Remedy components, such as survey benchmarks and monitoring well vault covers, were found to be in good conditions.

Navy controls access to the parcel using security fencing, signage, locks, and gates, which were found to be in good condition, with no signs of damage or vandalism.

3.4.3 Parcel B-2

The RA for Parcel B-2 includes the following major components:

- Soil excavation and removal to address COCs in soil
- Durable cover installation and maintenance to address COCs in soil
- ISS of mercury in groundwater at IR-26
- LTM and MNA of groundwater for COCs

- Radiological surveys and remediation through soil excavation and sampling during sanitary sewer line storm drain removal and through decontamination (and demolition/dismantling if necessary) buildings, structures, and former building sites
- ICs for soil, groundwater, and VOC vapors

Figures 3-1, 3-2, and 3-6 show the locations of major remedy components.

3.4.3.1 Remedy Implementation

Soil Excavation and Removal

Excavation and removal of soil containing COCs at concentrations greater than RGs were conducted from 2010 to 2011. In total, approximately 118 loose cubic yards of soil was excavated from two hotspot areas in Parcel B-2 to address lead and PAHs in soil and was disposed of offsite. Excavations were backfilled with clean imported soil. The *RACR for Soil Hotspot Locations at Parcel B, D-1, and G* (ERRG, 2011) documents completion of excavation activities and response complete.

Durable Cover Installation

Construction of the durable covers at Parcel B-2 began in 2012 and was completed in 2015. Completion of the durable covers along with ICs discussed in **Section 1.3.4.2** meets the RAOs for soil at Parcel B-2. Response complete is documented in the RACR for the Durable Covers Remedy in Parcel B-2 (Innovex-ERRG Joint Venture, 2018a). Durable covers consist of shoreline revetment, asphalt cover, and building foundations at Parcel B-2 shown on **Figure 3-6** and described as follows:

- **Shoreline Revetment:** Shoreline revetment was constructed along approximately 1,800 linear feet of shoreline at IR-23 and IR-26 (Innovex-ERRG Joint Venture, 2018a). An unforeseen discovery of TPH contamination along a 230-foot section of the IR-26 shoreline (in Parcel B-2) delayed completion of the revetment to allow for the TPH contamination to be delineated and removed. The shoreline revetment includes, from the bottom up, filter fabric, 6 to 12 inches of filter rock, and 2.5 to 3 feet of riprap. The filter fabric is designed to prevent migration of soil and sediment to San Francisco Bay; the filter rock and riprap layers protect the fabric from damage by wave action.
- **Asphalt Cover:** An asphalt concrete cover was constructed over the remaining upland areas of Parcel B-2 (Innovex-ERRG Joint Venture, 2018a). The asphalt cover consists of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete. Drainage features, such as swales, diversion berms, catch basins, and storm drain pipes, were incorporated into the asphalt cover to convey stormwater offsite.
- **Building Foundations:** Cracks and penetrations in building foundations were repaired using a variety of materials, such as concrete, non-shrink grout, and asphaltic concrete, to prevent access to underlying soil (Innovex-ERRG Joint Venture, 2018a). Additionally, access to soil under buildings (for example, crawl spaces) was blocked with durable wire mesh.

In Situ Stabilization of Mercury in Groundwater at IR-26

During the Third Five-Year Review for HPNS, the Navy identified that concentrations of mercury in groundwater at IR-26 Parcel B-2 continue to exceed the TL of 0.6 µg/L and recommended evaluation of the mass flux of mercury to San Francisco Bay to estimate potentially discharging mercury concentrations (Navy, 2013). An investigation to further evaluate the lateral and vertical extent of mercury in groundwater was conducted. The evaluation also included modeling, which

indicated that at the concentrations reported during sampling and based on site-specific hydrogeologic inputs, there is a potential that the discharge exceeds ambient levels (TriEco-Tt, 2016). As a result, ISS using an organo-sulfur compound injected into groundwater was completed in December 2017. The goal of the remedy was to reduce concentrations to be less than the TL of 0.6 µg/L in groundwater.

An estimated 32,000 pounds of the organo-sulfur compound MetaFix was injected into the subsurface at IR-26. A total of 43 of 52 planned injection locations were injected with a MetaFix -guar gum slurry using direct-push technology and a bottom-up injection pattern (KMJV, 2021). Four quarters of post-injection monitoring was included as part of the performance monitoring for the ISS injections. Additionally, the performance monitoring wells are also sampled for dissolved mercury (as well as other Parcel B COCs) as part of the BGMP.

Performance monitoring and review of BGMP data from the performance monitoring wells are as follows (KMJV, 2021; TRBW, 2023):

- IR26MW49A: Dissolved mercury exceeded the TL during baseline and performance and BGMP monitoring. The most recent dissolved mercury concentrations were 1.01 µg/L in March/April 2019, 3.45 µg/L in September 2019, 0.494 µg/L in June 2020, 3.57 µg/L in September 2021, and 1.79 µg/L and 5.55 µg/L in March and September 2022, respectively (TRBW, 2023). The Mann-Kendall statistical evaluation indicates a decreasing trend (KMJV, 2021).
- IR26MW50A: Dissolved mercury was not detected during baseline or any post-treatment monitoring.
- IR26MW51A: Dissolved mercury exceeded the TL during baseline sampling but was not detected during seven of eight post-treatment monitoring events through June 2020. The only detection exceeded the TL with a concentration of 1.66 µg/L in December 2019.
- IR26MW70A: Dissolved mercury was not detected during baseline or any post-treatment monitoring.
- IR26MW71A: Dissolved mercury exceeded the TL during baseline and performance monitoring. Concentrations fluctuated between less than detection limits to a high of 8.55 µg/L. In 2022 concentrations were 1.18 µg/L and 1.75 µg/L in March and September, respectively. Seasonal variability and possible localized releases from native sediment may be contributing factors to the continued fluctuations of dissolved mercury. Native sediment at this location consists of silty clay, organic materials, and silty sand to silty clay. The Mann-Kendall statistical evaluation concluded that there was insufficient evidence of a trend (KMJV, 2021).

After completion of the 3-year post-ISS treatment performance monitoring, the FFA regulatory agencies (USEPA Region 9, DTSC, and Regional Water Board) released a tri-agency letter on November 23, 2021 which reiterated that “mercury concentrations in groundwater along the San Francisco Bay margin consistently exceed the trigger level. Therefore, in-situ stabilization (ISS) has failed to minimize or prevent unacceptable discharge of mercury to the San Francisco Bay. Consequently, additional treatment options need to be screened, evaluated, and pursued by the Navy via the development of a new primary document work plan.” (USEPA, DTSC, and Regional Water Board, 2021).

As discussed at the April 25, 2024 meeting, the Navy stated it would move forward with optimizing ISS (e.g., use of a larger rig in areas of prior injection refusal) and the Navy

recognizes that USEPA does not oppose any Navy attempt to do so, as long as such action is timely and completed prior to July 31, 2025. As stated in the November 23, 2021 tri-agency letter, the Navy also recognizes that USEPA continues to expect that additional treatment options need to be screened, evaluated, and pursued by the Navy.

While there are continued exceedances of the TL in groundwater, the Navy's current assessment is that the following provides lines of evidence that the residual concentrations in mercury in groundwater are not likely to result in a concentration above 0.6 µg/L in the bay surface water:

- Completion of source removal in 2008 via a time-critical removal action (Insight, 2009).
- Partial success of the ISS as evidenced by reducing the extent of mercury exceedances of the TL from 3 performance monitoring locations to 2 performance monitoring locations and decreasing concentrations in one of the remaining locations (IR26MW49A). A time-series plot of data through 2023 for IR26MW49A, IR26MW51A, and IR26MW71A is presented on **Figure 3-7**. Mercury concentrations during the last 5 years of monitoring have been below historical maximums and are consistently below 10 times the HGAL.
- The limited extent of impacted groundwater; IR26MW71A and IR26MW49A are approximately 45 feet apart and IR26MW49A is approximately 88 feet from IR26MW51A with no exceedances.
- Comparison of groundwater quality parameters to Bay surface water quality parameters (temperature and dissolved oxygen, **Table 3-4**) indicate that the groundwater is not representative of Bay water because groundwater temperature is consistently warmer than surface water, and dissolved oxygen is consistently lower than surface water.

However, because there is uncertainty in the concentration at the exposure point and because the ISS remedy did not reduce the concentration in groundwater to below 0.6 µg/L at all monitoring wells, additional data collection, remedy optimization, and/or additional remedial alternatives/treatment that have been screened for further evaluation are necessary to determine whether the remedy is protective of the bay. Monitoring is ongoing under the BGMP. Mercury detections in 2022 were within the historical range of concentrations.

Groundwater Monitoring

Groundwater is sampled through the BGMP. At Parcel B-2, groundwater LTM was initiated in 2004 and currently consists of sampling 12 groundwater monitoring wells screened in the A-aquifer for VOCs, dichlorodifluoromethane (Freon-12), and metals, as well as MNA parameters. The BGMP is routinely optimized based on monitoring data. The sampling protocol for Parcel B-2 has not been amended. Annual and semiannual groundwater monitoring reports from 2019 through 2021 were also reviewed (TRBW, 2020b, 2020c, 2021, 2022a, 2022b, 2023). **Appendix E** presents exceedances of RGs (identified as PALs) from 2019, 2020, 2021, and 2022. **Figure 3-5** shows exceedances of RGs from 2022.

Freon-12, lead, and mercury were the only COCs that exceeded RGs or TLs during this review period. Historically, Freon-12 has been detected only in monitoring well IR26MW41A, and before September 2018, concentrations were highly variable (TRBW, 2022b). Freon-12 was not detected in monitoring well IR26MW41A in March 2021, which was the fifth consecutive event concentrations had been less than the RG of 14 µg/L, but then exceeded the RG in September 2021 with a concentration of 21 µg/L and was not detected in 2022. Lead exceeded the TL (14.44 µg/L) at IR26MW70A with a result of 17.7 µg/L in March 2022, it did not exceed in

September and was within the historic range for lead in Parcel B-2 (TRBW, 2023). Dissolved mercury exceedances have been previously discussed.

Radiological Surveys and Remediation

ROCs suspected to be present at Parcel B include cobalt-60 (Co-60), strontium-90 (Sr-90), cesium-137 (Cs-137), radium-226 (Ra-226), and plutonium-239 (Pu-239). The Navy conducted TCRA's at Parcel B (both Parcels B-1 and B-2) to address potential radioactive contamination in storm drains and sanitary sewer lines and radiologically impacted structures. In total, 65,184 cubic yards of soil was excavated during removal of 24,826 linear feet of sanitary sewer and storm drain lines. Approximately 6,641 cubic yards of soil was disposed of offsite as LLRW based on surface scan and analytical laboratory results. Additionally, FSSs were performed at two radiologically impacted buildings (130 and 140), and the Building 140 discharge channel (TtEC, 2012).

Institutional Controls

The land use and activity restrictions are described in the LUC RD Report (ChaduxTt, 2011a). As described in the Amended ROD (Navy, 2009), the entire area of Parcel B-2 is subject to soil and groundwater ICs. A portion of Parcel B-2 is also subject to ICs related to VOC vapors (**Figure 3-2**). The ARICs related to VOC vapors may be redefined when land is planned for transfer. **Table 1-3** summarizes the IC performance objectives to be implemented through land use restrictions for the site.

3.4.3.2 Remedy Operations and Maintenance

Ongoing O&M at Parcel B-2 includes maintaining the integrity of the revetment and asphalt cover and performing IC inspections. The inspection and maintenance requirements for the remedy are described in the Final O&M Plan for Parcel B-2 (Innovex-ERRG Joint Venture, 2018b). AOMSRs are prepared to summarize inspections and maintenance performed and to document the effectiveness of the remedy components. AOMSRs from 2019, 2020, 2021, and 2022 were reviewed (Innovex-ERRG Joint Venture, 2020, 2021a; APTIM, 2022, 2023).

Durable Cover Maintenance

The shoreline revetment was determined to be in good condition. No signs of vegetation or trash, pests, excessive vehicle traffic, settlement or movement, improper placement of fabric, vandalism or theft, cover soil overtopping, wave overtopping, or scouring were observed. The Navy is currently conducting a shoreline assessment study to identify and recommend repairs and/or stabilization of structures and shoreline.

The asphalt cover was generally found to be in good condition, except for two small areas of subsidence noted south of Building 140 during the September 2019 and October 2020 and potholes near Building 130 and Building 140 observed during the September 2021 inspection. The small subsidence areas damaged were repaired. Vegetation observed growing through cracks in the asphalt pavement cover was removed in October 2020 and December 2021.

Building foundations were found to be in good condition, with no new or expanding cracking. Generally, swales and check dams were clean and intact.

No settlement monuments were surveyed in Parcel B-2 during this review period. Based on the negligible change (less than 0.1 foot) in historical survey monument elevations, the next round of settlement monument surveys will be in 2024.

Institutional Controls Compliance

ICs are inspected annually, and no deficiencies or inconsistent uses were observed during the review. General site conditions were determined to be good. Remedy components, such as survey benchmarks and monitoring well vault covers, were found to be in good conditions.

The Navy controls access to the parcel using security fencing, signage, locks, and gates, which were found to be in good condition with no signs of damage or vandalism. However, during the September 2021 inspection, the metal hasp on a door that secures Building 159 was found broken during the annual inspection. The door was re-secured to Building 159 to prevent unauthorized access.

3.4.4 Progress Since the Fourth Five-Year Review

Table 3-5 summarizes issues, recommendations, and follow-up actions from the Fourth Five-Year Review.

3.5 Technical Assessment

3.5.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

3.5.1.1 IR-07/18

Yes. Based on the review of historical documents, annual IC inspections, and the Five-Year Review inspection, the remedy at IR-07/18 is functioning as intended.

Exposure pathways that could result in an unacceptable risk are being controlled through the durable covers and ICs. The shoreline revetment, soil cover, and asphalt cover are in good condition, and any minor issues have been repaired. No deficiencies or inconsistent uses of the ICs were observed during the inspections. Radiological concerns in soil are addressed by the cover with demarcation layer and ICs. Groundwater monitoring of metals and radionuclides is ongoing, and TLs were not exceeded during this review period.

3.5.1.2 Parcel B-1

Yes. Based on the review of historical documents, annual IC inspections, and the Five-Year Review inspection, the remedy at Parcel B-1 is functioning as intended.

Soil hotspot areas were removed through excavation and offsite disposal. Exposure pathways to residual COCs that could result in an unacceptable risk are being controlled through the durable covers and ICs. The soil cover, shoreline revetment, and asphalt cover are in good condition, and any minor issues have been repaired. VC and TCE groundwater exceedances of the RGs were reported for 2019 to 2021. The SVE system was operated as a source-reduction measure and reached a point of diminishing returns in 2020. Proposed work to remove the SVE system and to excavate soil exceedances (Insight-ESI, 2023) will further address VOC contamination at IR-10. No deficiencies or inconsistent uses of the ICs were observed during the inspections. Radiological concerns were addressed through previous radiological surveys and remediation of soil and building structures, and radiological retesting is being conducted to confirm that the RAO has been met, with the goal of unrestricted closure.

3.5.1.3 Parcel B-2

Uncertain. The ISS injections did not effectively reduce mercury in two locations (IR26MW49A and IR26MW71A) to below the TL of 0.6 µg/L. Although mercury continues to exceed TLs in

groundwater collected from downgradient monitoring wells, data demonstrating that mercury concentrations in surface water (the ultimate receptor) are below the HGAL of 0.6 µg/L still lacks. The RAO is stated as follows:

Prevent or minimize migration to the surface water of San Francisco Bay of chromium VI, copper, lead, and mercury in the A-aquifer groundwater that would result in concentrations of chromium VI above 50 µg/L, copper above 28.04 µg/L, lead above 14.44 µg/L, and mercury above 0.6 µg/L in the surface water of San Francisco Bay. This RAO is intended to protect the beneficial uses of the bay, including ecological receptors (Navy, 2009).

Data at the groundwater-surface water interface has not been collected; however, from the Navy's perspective, it is not expected that mercury exceeds 0.6 µg/L based on the following rationale:

- Source concentrations in soil have been removed during the IR-26 Mercury Removal TCRA (Insight, 2009).
- Although dissolved mercury in groundwater exceeds the TL in two locations, Mann-Kendall analysis indicates it is decreasing at one location (KMJV, 2021), indicating partial success of the ISS remedy at minimizing migration to the surface water.
- The TL is the Hunters Point groundwater ambient level (HGAL), which is not a risk-based concentration, formal RG, or ARAR according to the ROD Amendment (Navy, 2009).
- The screening of groundwater data against the TL or other surface water benchmarks, such as the National Recommended Water Quality Criteria (NRWQC; USEPA, 2023), conservatively assumes that ecological receptors are directly exposed to measured concentrations in groundwater. However, there will be a mixing zone where groundwater interfaces with surface water. The extent of that zone is unknown, but mixing is expected to occur, and the concentrations would decrease with distance from the mixing zone and tidal action. Site-specific mixing factors can range from 1 to several thousand. For example, USEPA uses a default mixing and attenuation factor of 20 to address the dilution of soil leachate as it moves through the groundwater aquifer (USEPA, 1996). Furthermore, mixing studies conducted by State of Washington, Department of Ecology (2009) found that the majority of the reduction in porewater concentrations was because of dilution by surface water and averaged 90 percent (that is, a dilution factor of 0.1). Assuming a similar dilution factor, the maximum post-injection detected concentration of dissolved mercury (8.55 µg/L) would be 0.855 µg/L, which does not exceed the NRWQC of 0.94 µg/L (USEPA, 2023).
- The post-treatment concentrations after 2018 have consistently been lower than 10 times the 0.6 µg/L TL at both IR26MW49A and IR26MW71A (**Figure 3-7**).
- Groundwater quality parameters (temperature and dissolved oxygen) indicate that the water in sentinel wells IR26MW49A, IR26MW50A, IR26MW51A, and IR26MW71A are not representative of surface water (**Table 3-4**).

Review of annual O&M inspections, historical documents, and the Five-Year Review inspection indicates that the durable covers and ICs are effective. Soil hotspot areas were removed through excavation and offsite disposal. Exposure pathways that could result in an unacceptable risk to human receptors are being controlled through the durable covers and ICs. The soil cover, shoreline revetment, and asphalt cover are in good condition, and any minor issues have been repaired. No deficiencies or inconsistent uses of the ICs were observed during the inspections.

Radiological concerns are addressed through past radiological work, and radiological retesting is being conducted to confirm that the RAO has been met, with the goal of unrestricted closure. With the exception of dissolved mercury at one location, groundwater monitoring indicates COCs in groundwater are decreasing or continue to be less than RGs and TLs.

3.5.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Selection Still Valid?

Yes. Based on the results of the ARAR evaluation, HHRA analysis, and ERA analysis discussed in the following sections, the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid. Although there have been some changes to toxicity values and risk assessment methods, these changes do not affect remedy protectiveness.

3.5.2.1 ARAR Evaluation

The Navy evaluated the ARARs established in the RODs for Parcel B. No changes to location-specific or action-specific ARARs that would affect the protectiveness of the remedies were identified. Changes to chemical-specific ARARs for individual chemicals are discussed in the following HHRA and ERA Analysis sections.

In 2021, California Public Resources Code Division 20.6.5, California Sea Level Rise Mitigation and Adaptation Act of 2021, was passed; however, no regulations have been promulgated to implement the act. The Navy is addressing SLR as discussed in **Section 1.4.2** of this Five-Year Review.

3.5.2.2 HHRA Analysis

The HHRA evaluation was conducted by comparing the human health RGs from the Amended ROD (Navy, 2009) with current risk-based criteria based on the same exposure scenario, and ARARs, if available. In September 2018, the State of California promulgated the *Toxicity Criteria for Human Health Risk Assessments, Screening Levels, and Remediation Goals* regulation (Toxicity Criteria Rule [TCR]). The TCR is codified at Cal. Code Regs., title 22, division 4.5, chapter 51, article 2, §§ 69020, 69021, and 69022. The TCR specifies the DTSC-preferred toxicity criteria (identified in TCR Appendix I, Tables A and B) to use to prepare HHRAs and to calculate screening levels and RGs based on human health risk at California hazardous waste and hazardous substance release sites. For this Five-Year Review, the USEPA recommended toxicity criteria hierarchy for HHRAs was followed to calculate the current comparison criteria discussed herein (USEPA, 2003):

- Tier 1 - USEPA Integrated Risk Information System (IRIS)
- Tier 2 - USEPA Provisional Peer-Reviewed Toxicity Values (PPRTVs)
- Tier 3 – Other sources in the order listed:
 - Agency for Toxic Substances and Disease Registry minimal risk levels
 - California Environmental Protection Agency Office of Environmental Health Hazard Assessment toxicity values
 - Screening toxicity values provided in USEPA PPRTV appendices
 - USEPA Health Effects Summary Table values

USEPA has incorporated this toxicity criteria hierarchy into its RSLs, which are updated semi-annually.

Response complete for soil is achieved with excavation, durable cover construction and maintenance, and ICs, as documented in the respective RACRs for IR-07/18, Parcel B-1, and Parcel B-2 (ERRG, 2011, 2012a, 2017; Innovex-ERRG Joint Venture, 2018a). Therefore, any changes in exposure assumptions and toxicity data would not affect protectiveness of the remedy.

Table 3-6 shows the RGs and current comparison criteria for groundwater. The RGs for the groundwater COCs in the Amended ROD (Navy, 2009) were based on consideration of exposure scenario-specific (residential or industrial vapor intrusion and construction worker trench exposure [A-aquifer], or residential domestic use [B-aquifer]) risk-based- concentrations (based on a cancer risk of 10^{-6} or a noncancer hazard index of 1), laboratory practical quantitation limits (PQLs), chemical-specific ARARs, and HGALs. RGs were compared with the following current comparison criteria (USEPA, 2022a):

- A-aquifer Groundwater: Vapor intrusion screening levels (VISLs) calculated using the current USEPA VISL calculator for the residential and commercial scenarios
- B-aquifer Groundwater: Current USEPA tap water RSLs, California MCLs, and USEPA MCLs

For the majority of the COCs where the risk-based concentration was selected as the RG, the current risk-based concentration (RSL, DTSC-screening level [SL], or VISL) is higher.

There are a few cases where a current risk-based concentration (VISL) is less than a risk-based RG (or the PQL or HGAL) from the Amended ROD (Navy, 2009; **Table 3-6**).

Although some current risk-based levels are less than the RGs, the ICs that are currently in place and the durable cover across the site prevent exposure to site media; therefore, the remedy remains protective. There may be changes with HHRA analysis for the construction worker scenario. Changes in exposure parameter values would likely only result in a small change to HHRA results since standard construction worker exposure factors have not changed significantly since the RI was prepared (not orders of magnitude). The following construction worker exposure parameter values have changed since the original HHRA was prepared:

- The construction worker body weight used in the HHRA was 70 kilograms; however, the adult body weight used in HHRA based on current USEPA guidance (USEPA, 2014) would be 80 kilograms.
- The skin surface area for a construction worker exposed to soil used in the HHRA was 5,700 square centimeters (cm^2); however, based on current USEPA guidance (USEPA, 2014), a construction worker skin surface area exposed to soil is 3,527 cm^2 .
- The soil-to-skin adherence factor used in the HHRA for a construction worker was 0.8 milligram per cm^2 , where the soil-to-skin adherence factor for a construction worker used in a current HHRA would be 0.3 milligram per cm^2 (the 95th percentile adherence factor for construction workers [USEPA, 2004]).
- The skin surface area for exposure to groundwater used in the HHRA was 2,370 cm^2 . A current HHRA would use a skin surface area of 6,032 cm^2 (the weighted average of mean values for head, hands, forearms, and lower legs [USEPA, 2011]).

- Additionally, for inhalation exposures for both groundwater and soil, inhalation toxicity values are now presented and used in milligram(s) per cubic meter (noncancer) or 1 microgram per cubic meter for cancer; therefore, the intake equations no longer incorporate inhalation rate.

Toxicity values could result in larger changes (potential orders of magnitude changes), such as for TCE, for which toxicity values were updated in 2009 after the initial HHRA was completed. However, those changes will not affect the RGs for the construction worker scenario identified in the ROD because ICs require identification and management of potential risks to construction workers through the preparation and approval of plans and specifications for all construction activities that may pose unacceptable exposure to construction workers. There have been no changes in current exposure pathways based on the site controls or changes in planned future site use since the ROD that would change the protectiveness of the current remedy.

Radiological Risk Review

In October 2020, after the preparation of the Five-Year Review addenda, USEPA introduced a PRG calculation method called “Peak PRG,” which computes PRGs accounting for ingrowth and decay of progeny over time. An evaluation was performed for this Five-Year Review to assess whether this change affected the continued protectiveness of the current soil RGs for future residents. Exposure calculations were performed using the USEPA PRG Calculator (USEPA, 2022b). For this soil evaluation, the estimated excess cancer risk was calculated using the “Peak Risk” time interval of 1,000 years (Navy, 2020). The soil RGs were used as exposure point concentrations, and the cumulative cancer risk was calculated as the sum of risks from all ROCs. **Appendix F** presents the estimated excess cancer risks calculated from this evaluation and the supporting data. Under CERCLA, cleanup goals are considered protective if excess cancer risks from site exposures remain within the 10^{-4} to 10^{-6} range. Based on the findings of this evaluation, the soil RGs are within this range and continue to be protective for future residential exposures.

There were no changes to the risk assessment methods related to structures or buildings for radiological concerns since the last Five-Year Review.

3.5.2.3 ERA Analysis

The ERA evaluation was conducted by reviewing the exposure and toxicity assumptions used in the SLERA, identifying the most sensitive receptor that was used as the basis of the ecological RGs or TLs and comparing them with current standards of practice for ERAs to determine if the RGs remain protective. Overall, the SLERA was a very conservative assessment, and minor changes to risk methodology or current sources of exposure and toxicity values do not significantly affect the resulting RGs or TLs. The key input parameters are summarized as follows:

- **Exposure Factors and Assumptions:** Potential exposures to sediment were evaluated for benthic invertebrates, birds, and mammals. Exposures were evaluated for both surface (0 to 2 feet bgs) and subsurface (2.5 to 4 feet bgs) sediments, although the biologically active zone is considered to occur within the top 0.5 foot bgs. The deeper sediments were evaluated under the assumption that erosion may expose deeper sediments to the surface. The sources of exposure factors for birds and mammals, including body weight, ingestion rate, and dietary items, are still in use today and represent current state of practice. Area use factors were not used to estimate potential exposure for birds or mammals (that is, receptors were assumed to spend 100 percent of their life within the site boundary).

- **Toxicity Values:** Toxicity values used for benthic invertebrates, birds, and mammals are still used in ERAs, although there are additional sources for some analytes that are more commonly used. Toxicity values used to evaluate potential risks to benthic invertebrates were effects range median (ERM) values (Long et al., 1995). Toxicity reference values (TRVs) used for birds and mammals were the Region 9 Biological Technical Assistance Group (BTAG) TRVs (USEPA Region 9 BTAG, 1998) or wildlife TRVs (Sample et al., 1996). The benthic invertebrate sediment ERMs and bird and mammal TRVs (Sample et al., 1996) are still commonly used. The Region 9 BTAG TRVs are not used as often and are typically placed after USEPA ecological soil screening level (EcoSSL)-based TRVs. The differences in TRVs between the sources vary depending on the analyte. For some analytes, the EcoSSL TRVs are more conservative than the Region 9 BTAG TRVs, and, for others, the EcoSSL TRVs are less conservative. However, overall use of the Region 9 BTAG TRVs in estimating risk or deriving RGs remains protective because area use factors were not used.
- **Risk Estimation:** Recommendations for retaining analytes as COCs were made based on hazard quotient exceeding 1 at the Low Effect toxicity level for at least one receptor group. Additional lines of evidence to weigh the significance of an exceedance were not employed.

Table 3-7 summarizes the sediment COCs identified for ecological receptors, along with the basis of the RGs, comparison with current state of practice, and evaluation of protectiveness. Overall, slight changes in toxicity values would not significantly change the results of the risk assessment or derivation of risk-based concentrations that were evaluated for use as RGs. The sediment RGs remain protective for ecological receptors.

Table 3-8 presents groundwater COCs with a summary of TLs and current surface water quality criteria from NRWQC (USEPA, 2023) and the San Francisco Basin Plan (SFRWCQB, 2019). Groundwater data were compared with surface water screening levels and HGALs in the SLERA to evaluate potential for risk to aquatic organisms in San Francisco Bay. The evaluation of groundwater was very conservative because it was assumed that aquatic receptors would have direct exposure to chemicals in groundwater at their measured concentrations.

Mercury was the only metal retained as a potential risk to aquatic organisms in the SLERA. Chromium VI, copper, and lead were also included in the groundwater RAO based on review of data during the Amended ROD (Navy, 2009). The chronic NRWQC for chromium VI and the HGALs for copper, lead, and mercury were retained as TLs for monitoring purposes only as surface water benchmarks are not ARARs for ecological exposures to groundwater.

There have been no changes in site conditions or exposure parameters or mercury toxicity values that would call into question the selected trigger level of 0.6 µg/L, which is the background concentration of mercury in groundwater. The calculation methods and supporting information for this value are provided in the Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum (PRC, 1996a).

3.5.3 Question C: Has Any Other Information Come to Light that Could Question the Protectiveness of the Remedy?

Yes. As identified in the Fourth Five-Year Review, there is uncertainty with the radiological survey and remediation work. The Navy is in the process of implementing corrective actions to ensure the radiological remedies specified in the decision documents were implemented as intended; however, this work is ongoing. Radiological retesting is currently being conducted at Parcels B-1 and B-2; long-term protectiveness will be confirmed upon completion. Until retesting

is complete, Navy controls access to the parcel through fencing, locked gates and institutional controls (restricting intrusive work and maintaining durable covers).

3.6 Issues, Recommendations, and Follow-up Actions

Table 3-9 summarizes the identified issues, recommendations, and follow-up actions for Parcels B-1 and B-2.

No issues have been identified for IR-07/18 that prevent the remedy from being protective of human health and the environment; therefore, no recommendations or follow-up actions are required to ensure protectiveness of the remedy.

3.6.1 Other Findings

The following findings were identified that do not affect current or future remedy protectiveness but warrant consideration as part of CERCLA cleanup and site management.

3.6.1.1 PFAS

As discussed in **Section 1.4.1**, a Basewide PA was conducted to identify potential PFAS release areas based on historical use or limited sampling data. The following is a summary of the areas identified for additional investigation in the PA (Multi-MAC JV, 2022) and SI (Liberty JV, 2023):

- **Parcels B-1 and B-2 A-aquifer Groundwater:** A-aquifer groundwater beneath Parcels B-1 and B-2 was identified for additional investigation because of past industrial use in the parcels and PFOA, PFOS, PFNA, and PFHxS exceeded project screening levels during the SI (**Appendix G**).
- **Parcel B-1:** IR-10, Battery and Metal Plating Shop, was identified as an area where further investigation is warranted to determine the presence of PFAS in soil and groundwater based on historical site use and limited groundwater sampling results that detected PFOA, PFOS, PFNA, PFBS, and PFHxS. PFOA, PFOS, and PFNA exceeded project screening levels in groundwater during the SI (**Appendix G**).

Exposure to groundwater and soil is restricted by ICs within the HPNS, and the City and County of San Francisco prohibits installation of domestic wells within city and county limits.

3.6.1.2 Climate Resilience

The CRA estimates that groundwater emergence may occur within IR-07/18 and Parcels B-1 and B-2 by the year 2065 (**Appendix A**). Site-specific studies are planned to verify these mapping projections and evaluate the 2100 timeframe, at a minimum.

However, protectiveness is only affected when increased CERCLA risk attributable to climate hazards has been identified (groundwater is likely to emerge and land use is such that receptors could be exposed and a future unacceptable health or ecological risk has been identified, data collected, validated, and evaluated following CERCLA risk assessment processes resulting in unacceptable risk to receptors). Where the potential for increased vapor intrusion is identified in other CERCLA documents, ARICs for VOCs are present, groundwater is being monitored, and removal of VOCs is occurring either through MNA or active remediation, thus reducing the potential for future vapor intrusion by reducing the source. Therefore, the potential for groundwater emergence does not affect the protectiveness determination in this Five-Year Review.

3.6.1.3 Site Management Strategy

The Navy is reassessing the site management strategy for Parcel B based on the following considerations:

- The Navy is planning to conduct a detailed assessment of groundwater COC concentrations to document and eliminate COCs that have achieved response complete and to tabulate groundwater and soil COC concentrations to ensure health and safety professionals have the information needed to protect future construction workers.
- The Navy is also planning to optimize the monitoring frequency and locations for areas that have not undergone any changes that could affect the concentrations of chemicals, metals, and/or ROPCs in groundwater (for example, RA or development construction).

3.7 Statement of Protectiveness

3.7.1 IR-07/18

Protectiveness Determination: Protective

Protectiveness Statement: The remedy at IR-07/18 is protective of human health and the environment.

The RAOs for soil and soil gas have been met through excavation and removal of contaminated soil, durable covers, and ICs. Groundwater monitoring indicates that COCs and ROPCs are less than TLs during the majority of sampling events.

3.7.2 Parcel B-1

Protectiveness Determination: Short-term Protective

Protectiveness Statement: The remedy at Parcel B-1 is currently protective of human health and the environment. To determine whether the remedy can be considered protective in the long term, the radiological retesting work and the excavation of VOC-impacted soil will be completed.

The RAOs for soil are met through hotspot excavation and offsite disposal, durable covers, and ICs. Excavation of VOC-impacted soil will permanently remove the source of VOCs to soil gas and groundwater. Groundwater LTM and MNA is ongoing. Exposure to groundwater is controlled through ICs. Radiological retesting is ongoing to confirm that levels in soils and structures are protective of human health. Until retesting is complete, short-term protectiveness is met through Navy controls such as access to the parcel through fencing, locked gates, and ICs (restricting intrusive work and maintaining durable covers).

3.7.3 Parcel B-2

Protectiveness Determination: Protectiveness Deferred

Protectiveness Statement: A protectiveness determination cannot be made because there is uncertainty related to the concentrations of mercury discharging to the Bay from Parcel B-2, IR-26 groundwater. In order to make a protectiveness determination, the following actions need to be made: (1) evaluate technologies for treating mercury in groundwater (2) apply the selected method that is within compliance of the selected remedy in the record of decision. A draft primary document presenting the evaluation of the technologies and the proposed treatment method will be provided to the FFA regulatory agencies for review by October 31, 2024. The Navy anticipates initiating field application of the selected treatment method by Mid-July 2025.

Contingencies will be discussed during development of the work plan and exercised as the need arises. The protectiveness determination will be re-evaluated in the Five-Year Review addendum based on information that becomes available after the completion of this FYR. The RAOs for soil are met through durable covers and ICs. Groundwater LTM and MNA is ongoing. Exposure to groundwater is controlled through ICs. Radiological retesting is ongoing to confirm that levels in soil and structures are protective of human health.

3.8 References

- Aptim Federal Services, LLC (APTIM). 2022. *2021 Annual Operation and Maintenance Summary Report, Parcels B-1, B-2, C, D-1, G, and UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. February 1.
- APTIM. 2023. *2022 Annual Operation and Maintenance Summary Report, Parcels B-1, B-2, C, D-1, G, and UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. February 1.
- California Department of Public Health (CDPH). 2013. *Concurrence with the Draft IR-07 and IR-18 Radiological Risk and Dose Modeling Review, April 23, 2012, Hunters Point Naval Shipyard, San Francisco Bay, California*. May 20.
- ChaduxTt, A Joint Venture of St. George Chadux Corp. And Tetra Tech EM Inc. (ChaduxTt). 2007. *Parcel B Technical Memorandum in Support of a Record of Decision Amendment, Hunters Point Shipyard, San Francisco, California*. Final. December 12.
- ChaduxTt. 2008. *Construction Summary Report for Parcel B, Hunters Point Shipyard, San Francisco, California*. Final. July 25.
- ChaduxTt. 2010. *Remedial Design Package, Installation Restoration Sites 7 and 18, Parcel B, Hunters Point Naval Shipyard, San Francisco, California*. Final. January 8.
- ChaduxTt. 2011a. *Land Use Control Remedial Design Package, Parcel B (Excluding Installation Restoration Sites 7 and 18), Hunters Point Naval Shipyard, San Francisco, California*. Revised Final. July 5.
- Department of the Navy (Navy). 1997. *Hunters Point Shipyard, Parcel B, Final Record of Decision*. Engineering Field Activity West, Naval Facilities Engineering Command. October 7.
- Navy. 1998. *Explanation of Significant Differences, Parcel B, Hunters Point Shipyard, San Francisco, California*. Final. August 24.
- Navy. 2000. *Explanation of Significant Differences, Parcel B, Hunters Point Shipyard, San Francisco, California*. Final. May 4.
- Navy. 2006. *Base-wide Radiological Removal Action, Action Memorandum – Revision 2006, Hunters Point Shipyard, San Francisco, California*. Final. April 21.
- Navy. 2009. *Amended Parcel B Record of Decision, Hunters Point Naval Shipyard, San Francisco, CA*. Final. January 14.
- Navy. 2010. *Remedial Action Monitoring Plan – Installation Restoration Sites 7 and 18 – Parcel B, Hunters Point Shipyard, San Francisco, California*. Final. January 8.
- Navy. 2013. *Third Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California*. November.

Navy. 2019. *Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California*. July.

Navy. 2020. *Addendum to the Five-Year Review, Evaluation of Radiological Remedial Goals for Soil, Hunters Point Naval Shipyard, San Francisco, CA*. June 18.

Engineering/Remediation Resources Group, Inc. (ERRG). 2011. *Remedial Action Completion Report for Soil Hotspot Locations at Parcels B, D-1, and G and Soil Stockpiles at Parcels D-1 and G, Hunters Point Naval Shipyard, San Francisco, California*. Final. October 7.

ERRG. 2012a. *Remedial Action Completion Report for Installation Restoration Sites 07 and 18 at Parcel B, Hunters Point Naval Shipyard, San Francisco, California*. Final. May 11.

ERRG. 2012b. *Operation and Maintenance Plan for Installation Restoration Sites 07 and 18 in Parcel B, Hunters Point Naval Shipyard, San Francisco, California*. Final. October.

ERRG. 2012c. *Annual Operation and Maintenance Summary Report for Installation Restoration Sites 07 and 18 in Parcel B, Hunters Point Naval Shipyard, San Francisco, California*. October 4.

ERRG. 2015. *Remedial Action Completion Report for Parcel B-1, Hunters Point Naval Shipyard, San Francisco, California*. Draft. February.

ERRG. 2016. *Operation and Maintenance Plan for Parcel B-1, Hunters Point Naval Shipyard, San Francisco, California*. Final. June.

ERRG. 2017. *Remedial Action Completion Report for the Durable Covers Remedy in Parcel B-1, Hunters Point Naval Shipyard, San Francisco, California*. Final. January.

Innovex-ERRG Joint Venture. 2018a. *Remedial Action Completion Report for the Durable Covers Remedy in Parcel B-2, Hunters Point Naval Shipyard, San Francisco, California*. Final. April 6.

Innovex-ERRG Joint Venture. 2018b. *Operation and Maintenance Plan for Parcel B-2, Hunters Point Naval Shipyard, San Francisco, California*. Final. July.

Innovex-ERRG Joint Venture. 2020. *Annual Operation and Maintenance Summary Report for Parcels B-1, B-2, C, G, UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. January 8.

Innovex-ERRG Joint Venture. 2021a. *Annual Operation and Maintenance Summary Report for Parcels B-1, B-2, C, D-1, G, UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. January.

Innovex-ERRG Joint Venture. 2021b. *SVE System Operation, Maintenance, and Monitoring Status Update for October 2019-September 2020 Operating Period, IR-10 Carveout, Parcel B-1, Hunters Point Naval Shipyard, San Francisco, California*. Final. February 1.

Insight Environmental, Engineering, and Construction, Inc. (Insight). 2009. *Hunters Point Shipyard, Parcel B, IR-26 Time Critical Removal Action, Removal Action Closeout Report*. Final. January.

Insight-ESI, LLC (Insight-ESI). 2023. *Remedial Action Work Plan, Parcel B-1, Installation Restoration Site 10, Building 123, Hunters Point Naval Shipyard, San Francisco, California*. Final. September.

KMEA MACTEC Joint Venture (KMJV). 2021. *Remedial Action Construction Summary Report, Parcel B-2, Installation Restoration Site 26 Groundwater Treatment, Former Hunters Point Naval Shipyard, San Francisco, California*. December 9.

Liberty Joint Venture (Liberty JV). 2023. *Inspection for Basewide Investigation of Per- and Polyfluoroalkyl Substances, Former Hunters Point Naval Shipyard, San Francisco, California*. Final. September.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments." *Environmental Management*. Vol. 19, No. 1. Pp. 81–97.

Multi-MAC Joint Venture (Multi-MAC JV). 2022. *Preliminary Assessment Report Basewide Investigation of Per- and Polyfluoroalkyl Substances (PFAS), Former Hunters Point Naval Shipyard, San Francisco, California*. June.

PRC Environmental Management, Inc. (PRC). 1996a. *Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum, Hunters Point Shipyard, San Francisco, California*. September 16.

PRC. 1996b. *Parcel B Feasibility Study, Final Report, Hunters Point Shipyard, San Francisco, California*. November 26.

PRC Environmental Management, Inc. (PRC), Harding Lawson Associates, Levine-Fricke, and Uribe & Associates. 1996. *Parcel B Remedial Investigation Report, Hunters Point Shipyard, San Francisco, California*. Draft Final. June 3.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. ES/ER/TM-86/R3. ORNL, Oak Ridge, Tennessee.

San Francisco Bay Region Water Quality Control Board (SFRWQCB). 2019. *San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan)*. California Regional Water Quality Control Board – San Francisco Bay Region. November.

San Francisco Redevelopment Agency (SFRA). 1997. *Hunters Point Shipyard Redevelopment Plan*. July 14.

San Francisco Office of Community Investment and Infrastructure (OCII). 2018. *Redevelopment Plan for the Hunters Point Shipyard Project Area*. July 16 (Amendment to July 14, 1997 plan and August 3, 2010 and June 22, 2017 amendments).

SES-TECH Remediation Services, Inc. (SES-TECH). 2009. *Removal Action Completion Report, Time-Critical Removal Action for the Methane Source Area at IR-07, Parcel B, Hunters Point Shipyard, San Francisco, California*. Final. May.

State of Washington, Department of Ecology. 2009. *High-resolution porewater sampling near the groundwater/surface water interface*. Publication No. 09-03-017. April.

Tetra Tech. 2001. *Final Technical Memorandum, Distribution of the Bay Mud Aquitard and Characterization of the B-Aquifer in Parcel B, Hunters Point Shipyard, San Francisco, California*. February 19.

Tetra Tech EC, Inc. (TtEC). 2012. *Radiological Removal Action Completion Report, Parcel G, Hunters Point Naval Shipyard, San Francisco, California*. March 2.

TriEco-Tetra Tech Sustainable Resources Joint Venture (TriEco-Tt). 2016. *Final Mercury Evaluation Technical Memorandum, Installation Restoration Site 26, Parcel B-2, Hunters Point Naval Shipyard, San Francisco, California.* May.

Trevet-Bay West JV LLC (TRBW). 2020a. *Technical Memorandum Optimization of the Management and Monitoring Approach Sampling and Analysis Plan for Basewide Groundwater Monitoring Program, Hunters Point Naval Shipyard, San Francisco, California.* Final. March 1.

TRBW. 2020b. *Summary of July through December 2019 Semiannual Groundwater Monitoring Data and Exceedances in Groundwater, Hunters Point Naval Shipyard, San Francisco, California.* Final. May 1.

TRBW. 2020c. *2019 Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California.* Final. June.

TRBW. 2021. *Summary of January through June 2021 Semiannual Groundwater Monitoring Data and Exceedances in Groundwater, Hunters Point Naval Shipyard, San Francisco, California.* August 31.

TRBW. 2022a. *2020 Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California.* Final. January.

TRBW. 2022b. *2021 Basewide Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California.* Final. August.

TRBW. 2023. *2022 Basewide Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California.* Final. December.

United States Environmental Protection Agency (USEPA). 1996. *Soil Screening Guidance: User's Guide.* Office of Solid Waste and Emergency Response. EPA/540/R-96/0016. April.

USEPA. 2000. *Radionuclides Notice of Data Availability Technical Support Document.* Targeting and Analysis Branch, Standards and Risk Management Division, Office of Groundwater and Drinking Water. March.

USEPA. 2003. *Human Health Toxicity Values in Superfund Risk Assessments.* Memorandum from Michael B. Cook, Director, to Superfund National Policy Managers, Regions 1–10. Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-53. December 5.

USEPA. 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final)).* EPA/540/R/99/005. July.

USEPA. 2011. *Exposure Factors Handbook: 2011 Edition.* National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F. September.

USEPA. 2014. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors,* OSWER Directive 9200.1-120, February 6.

USEPA. 2022a. *Preliminary Remediation Goals (PRG) for Radionuclides Calculator.*

USEPA. 2022b. *Regional Screening Levels for Chemical Contaminants at Superfund Sites.* November.

USEPA. 2023. *National Recommended Water Quality Criteria (NRWQC) for Priority Pollutants.* <https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table>.

United States Environmental Protection Agency Region 9 Biological Technical Assistance Group (USEPA Region 9 BTAG). 1998. *Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California, Interim Final Technical Memorandum*. Prepared for Naval Facilities Engineering Command, Engineering Field Activity West, San Bruno, California. September.

USEPA, DTSC, and Regional Water Board. 2021. Letter to Ms. Liz Roddy, Remedial Project Manager, NAVFAC BRAC PMO West. Subject: Draft Final Remedial Action Construction Summary Report (RACSR), Parcel B-2 Installation Restoration (IR) Site 26, Groundwater Treatment (October 2021), Hunters Point Naval Shipyard, San Francisco; United States Environmental Protection Agency, California Department of Toxic Substances Control, and San Francisco Bay Regional Water Quality Control Board Reiteration of Position Letter on Ongoing, Unacceptable Mercury Discharges to the San Francisco Bay. November 23.

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HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CALIFORNIA

3.0 FORMER PARCEL B (INSTALLATION RESTORATION SITES 07 AND 18, PARCELS B-1 AND B-2)

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Table 3-1. Parcel B Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	Amended ROD Remediation Goal (2009)	Source of Remediation Goal
Soil (mg/kg)	Residential	Antimony	10	RBC
		Aroclor-1254	0.093	RBC
		Aroclor-1260	0.21	RBC
		Arsenic	11.1	HPAL
		Benzo(a)anthracene	0.37	RBC
		Benzo(a)pyrene	0.33	PQL
		Benzo(b)fluoranthene	0.34	RBC
		Benzo(k)fluoranthene	0.34	RBC
		Beta-BHC	0.0066	RBC
		Bis(2-ethylhexyl)phthalate	1.1	RBC
		Cadmium	3.5	RBC
		Copper	159	RBC
		Dibenz(a,h)anthracene	0.33	PQL
		Dieldrin	0.0034	PQL
		Heptachlor epoxide	0.0017	PQL
		Indeno(1,2,3-cd) pyrene	0.35	RBC
		Iron	58,000	HPAL
		Lead	155	RBC
		Manganese	1,431	HPAL
		Mercury	2.3	HPAL
		Naphthalene	1.7	RBC
		Tetrachloroethene	0.48	RBC
		Trichloroethene	2.9	RBC
		Vanadium	117	HPAL
		Zinc	373	RBC
	Recreational	Aroclor-1254	0.74	RBC
		Aroclor-1260	0.74	RBC
		Arsenic	11.1	HPAL
		Benzo(a)pyrene	0.33	PQL
		Lead	155	RBC
	Industrial	Arsenic	11.1	HPAL
		Benzo(a)anthracene	1.8	RBC
		Benzo(a)pyrene	0.33	PQL
	Construction Worker	Aroclor-1260	2.1	RBC
		Arsenic	11.1	HPAL
		Benzo(a)pyrene	0.65	RBC
		Lead	800	RBC
		Trichloroethene	151	RBC
Sediment (mg/kg)	Ecological Receptor	Aluminum	3400	RBC
		Copper	270	RBC
		Dibenz(a,h)anthracene	0.33	PQL
		Dieldrin	0.008	RBC
		Lead	218	RBC
		Methoxychlor	0.4	RBC
		Total Aroclors	0.18	RBC
		Total DDT	0.046	RBC
		Zinc	410	RBC

Table 3-1. Parcel B Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	Amended ROD Remediation Goal (2009)	Source of Remediation Goal
Groundwater - A-aquifer (µg/L)	Residential Vapor Intrusion	1,2,4-Trichlorobenzene	66	RBC
		1,2,4-Trimethylbenzene	25	RBC
		1,2-Dichlorobenzene	2,561	RBC
		1,2-Dichloroethane	2.3	RBC
		1,2-Dichloroethene (total)	209	RBC
		1,2-Dichloropropane	1.1	RBC
		1,3,5-Trimethylbenzene	19	RBC
		1,4-Dichlorobenzene	2.1	RBC
		2-Methylnaphthalene	707	RBC
		Benzene	0.5	PQL
		Bromodichloromethane	1	RBC
		Chlorobenzene	392	RBC
		Chloroethane	6.5	RBC
		Chloroform	1	PQL
		cis-1,2-Dichloroethene	209	RBC
		Dichlorodifluoromethane	14	RBC
		Mercury	0.68	RBC
		Methylene chloride	27	RBC
		Naphthalene	3.6	RBC
		Tetrachloroethene	1	PQL
		trans-1,2-Dichloroethene	182	RBC
		Trichloroethene	2.9	RBC
		Trichlorofluoromethane	176	RBC
		Vinyl chloride	0.5	PQL
	Industrial Vapor	Chloroform	1.2	RBC
	Construction Worker Trench Exposure	1,2,4-Trichlorobenzene	55	RBC
		1,2,4-Trimethylbenzene	72	RBC
		1,2-Dichlorobenzene	2,215	RBC
		1,2-Dichloroethane	30	RBC
		1,2-Dichloroethene (total)	363	RBC
		1,2-Dichloropropane	40	RBC
		1,4-Dichlorobenzene	68	RBC
		2,4,6-Trichlorophenol	15	RBC
		2,4-Dimethylphenol	9,801	RBC
		2,4-Dinitrotoluene	179	RBC
		2-Methylnaphthalene	140	RBC
		4-Methylphenol	3,500	RBC
		Arsenic	40	RBC
		Benzene	22	RBC
		Benzo(a)anthracene	2	PQL
		Benzo(a)pyrene	2	PQL
		Bromodichloromethane	26	RBC
		Chlorobenzene	594	RBC
		Chloroform	36	RBC
		Chrysene	6.4	RBC
		cis-1,2-Dichloroethene	363	RBC
		Mercury	4.68	RBC
		Naphthalene	20	RBC
		Pentachlorophenol	25	PQL
		Tetrachloroethene	19	RBC
		trans-1,2-Dichloroethene	721	RBC
		Trichloroethene	374	RBC
		Vinyl chloride	7.2	RBC

Table 3-1. Parcel B Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	Amended ROD Remediation Goal (2009)	Source of Remediation Goal
Groundwater - B-aquifer (µg/L)	Residential Domestic Use	1,4-Dichlorobenzene	7.5	ARAR
		Antimony	43.26	HGAL
		Arsenic	27.34	HGAL
		Benzene	5	ARAR
		Chloroethane	4.6	RBC
		Manganese	8,140	HGAL
		Pentachlorophenol	25	PQL
		Thallium	12.97	HGAL
		Trichloroethene	5	ARAR

µg/L = microgram(s) per liter

ARAR = applicable or relevant and appropriate requirement

BHC = benzene hexachloride

DDT = dichlorodiphenyltrichloroethane

HGAL = Hunters Point groundwater ambient level

HPAL = Hunters Point ambient level

mg/kg = milligram(s) per kilogram

PQL = practical quantitation limit

RBC = risk-based concentration

ROD = Record of Decision

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Table 3-2. Parcel B Remediation Goals for Radionuclides

Radionuclide	Surfaces (dpm/100cm ²)		Soil ^c (pCi/g)		Water ^e (pCi/L)
	Equipment, Waste ^a	Structures ^b	Construction Worker	Residential ^g	Equipment, Waste ^a
Cesium-137	5,000	5,000	0.113	0.113	119
Cobalt-60	5,000	5,000	0.0602	0.0361	100
Plutonium-239	100	100	14	2.59	15
Radium-226	100	100	1.0 ^d	1.0 ^d	5.0 ^f
Strontium-90	1,000	1,000	10.8	0.331	8

References:

Department of the Navy (Navy). 2006. *Base-wide Radiological Removal Action, Action Memorandum – Revision 2006, Hunters Point Shipyard, San Francisco, California*. Final. April 21.

United States Environmental Protection Agency (USEPA). 2000. *Radionuclides Notice of Data Availability Technical Support Document*. Targeting and Analysis Branch, Standards and Risk Management Division, Office of Groundwater and Drinking Water. March.

^a Based on "AEC Regulatory Guide 1.86" (1974); goals for removable surface activity are 20 percent of these values.

^b Goals are based on 25 millirem per year (USEPA does not believe this NRC regulation is protective of human health and the environment, and the HPNS cleanup goals are more protective. This regulation is an ARAR only for radiologically impacted sites that are undergoing TCRAs, and any additional remedial action required for those sites. It is not an ARAR for radiologically impacted portions of IR-07/18 that will be transferred with engineering and institutional controls for radiological contaminants.

^c USEPA PRGs for two future use scenarios

^d Goal is 1 pCi/g above background per agreement with USEPA.

^e Release criteria for water were derived from *Radionuclides Notice of Data Availability Technical Document* (USEPA, 2000) by comparing the limits from two criteria and using the most conservative value.

^f Goal is for total radium concentration.

^g Also applies to scanned surface soil at IR-07/18.

AEC = Atomic Energy Commission

ARAR = applicable or relevant and appropriate requirement

cm² = square centimeter(s)

dpm = disintegration(s) per minute

HPNS = Hunters Point Naval Shipyard

NRC = Nuclear Regulatory Commission

pCi/g = picocurie(s) per gram

pCi/L = picocurie(s) per liter

PRG = preliminary remediation goal

TCRA = time-critical removal action

USEPA = United States Environmental Protection Agency

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Table 3-3. Parcel B Remedial Action Summary and Expected Outcomes

Media	Risk/Basis for Action	Reasonably Anticipated Land Use	RAO	Remedy Component	Parcel ^a	Performance Metric	Expected Outcome
Soil, Soil Gas, and Sediment	<p>Human Health: Unacceptable risk to industrial workers from exposure to metals and SVOCs; recreational users from exposure to metals, SVOCs, and PCBs; residents from exposure to metals, VOCs, SVOCs, pesticides, and PCBs; and construction worker from metals, VOCs, and SVOCs in surface or subsurface soil and VOCs in indoor air via the vapor intrusion pathway</p> <p>Planned future use: Predominantly residential and shoreline open space</p> <p>Potential presence of ROCs in soil beneath the cover at IR-07/18</p>	<p>1. Prevent exposure to organic and inorganic compounds in soil at concentrations above remediation goals developed in the HHRA (Table 8-1 from the Amended ROD [Navy, 2009]) for the following exposure pathways:</p> <p>a) Ingestion of, outdoor inhalation of, and dermal exposure to soil</p> <p>b) Ingestion of homegrown produce by residents in research and development and mixed-use reuse areas.</p>	<p>1. Prevent exposure to organic and inorganic compounds in soil at concentrations above remediation goals developed in the HHRA (Table 8-1 from the Amended ROD [Navy, 2009]) for the following exposure pathways:</p> <p>a) Ingestion of, outdoor inhalation of, and dermal exposure to soil</p> <p>b) Ingestion of homegrown produce by residents in research and development and mixed-use reuse areas.</p>	Soil Excavation	IR-07/18	Approximately 69,900 cubic yards of soil was removed from IR-07/18 from 1998 to 2001; however, RGs were not met and the soil remedy approach from the 1997 ROD (Navy, 1997) was re-evaluated to address ubiquitous metals and remaining COCs in soil. The Amended ROD (Navy, 2009) documents a parcel-wide application of durable covers to address these risks.	Land suitable for planned future use compatible with durable covers and ICs as required by the LUC RD.
				B-1 and B-2	Hotspot excavation to remove lead and PAH-impacted soil from the site to prevent exposure to humans and wildlife. Excavations were backfilled with clean imported soil		
				IR-07/18	Durable covers to provide physical barriers to prevent exposure of humans and wildlife include the following:		
					1) A 3-foot (minimum) vegetated soil cover with a demarcation layer over IR-07/18 upland areas within the ARIC		
					2) A 2-foot (minimum) vegetated soil cover over IR-07/18 upland areas outside of the ARIC		
				Durable Covers	3) A 6-inch (minimum) asphalt cover comprising 4 inches of aggregate base and 2 inches of asphalt over IR-07/18 upland areas outside of the ARIC that required paving		
					Covers are inspected and maintained to prevent exposure to COCs and ROCs.		
					Durable covers to provide physical barriers to prevent exposure of humans and wildlife include the following:		
				B-1 and B-2	1) A 2-foot-thick (minimum) vegetated soil cover		
					2) A 6-inch-thick (minimum) asphaltic pavement cover		
3) Repaired concrete building foundations							
ICs	Covers are inspected and maintained to prevent exposure to COCs.						
	ICs to maintain durable covers and security features, restrict land-disturbing activities, and prohibit growing produce in native soil for human consumption						
	SVE						
Soil Excavation	2. Prevent exposure to VOCs in soil gas at concentrations that would pose unacceptable risk (that is, risk greater than 10 ⁻⁶) via indoor inhalation of vapors.	B-1	Planned: Excavation to remove VOC-impacted soil source area beneath Building 123 (IR-10), backfilling with clean fill, and post-excavation soil vapor monitoring to SGALs for residential use				
			ICs	ICs to prohibit construction of enclosed structures unless prior written approval of vapor mitigation strategies is granted by the FFA signatories			
			Soil Gas LTM	Soil gas LTM to monitor concentrations of residual methane. Post-TCRA methane concentrations have been reduced to less than the lower explosive limit, and monitoring was discontinued in 2012.			
ICs	3. Reduce presence of methane in soil gas so that concentrations do not accumulate and become explosive in structures.	IR-07/18	ICs to prohibit construction of enclosed structures unless prior written approval of vapor mitigation strategies is granted by the FFA signatories and the CDPH				

Table 3-3. Parcel B Remedial Action Summary and Expected Outcomes

Media	Risk/Basis for Action	Reasonably Anticipated Land Use	RAO	Remedy Component	Parcel ^a	Performance Metric	Expected Outcome
Groundwater	Ecological: Potential unacceptable risk to benthic invertebrates, birds, and mammals from metals, pesticides, and PCBs in sediment Human Health: Risk to industrial workers and residents from VOCs in A-aquifer through the vapor intrusion pathway; construction workers through direct contact with VOCs, SVOCs, and metals in A-aquifer groundwater and vapors in trenches; and residents through VOCs, and metals in B-aquifer groundwater from domestic use	Current use: Limited access unoccupied and unused buildings, few commercial buildings Planned future use: Predominantly residential and shoreline open space	4. Prevent or minimize exposure of ecological receptors to organic and inorganic compounds in soil and sediment in shoreline areas at concentrations above remediation goals established for sediment (Table 8-1 from Amended ROD [Navy, 2009]).	Durable Cover	All	Durable covers to provide physical barriers to prevent exposure of humans and wildlife to COCs along the shoreline. Durable cover consists of a 3-foot-thick (minimum) shoreline revetment structure made of riprap with underlying geotextile. Covers are inspected and maintained to prevent exposure to COCs.	Land suitable for planned future use compatible with durable covers and ICs as required by the LUC RD.
			1. Prevent exposure to VOCs and mercury in the A-aquifer groundwater at concentrations above remediation goals via indoor inhalation of vapors from groundwater (Table 8-3 from Amended ROD [Navy, 2009]).	In Situ Groundwater Remediation and Monitoring	B-1	Polylactate hydrogen was injected into 45 groundwater injection points to treat the VOC plume near Building 123 in IR-10. Post-injection monitoring is ongoing.	
				ICs	B-2	Organo-sulfur compound was injected into 43 groundwater injection points to treat dissolved mercury plume at IR-26 to the TL. Results were mixed and mercury continues to exceed TLs in downgradient monitoring wells.	
				ICs	B-1 and B-2	ICs to prohibit construction of enclosed structures unless prior written approval of vapor mitigation strategies is granted by the FFA signatories	
			2. Prevent direct exposure to B-aquifer groundwater at concentrations above remediation goals (Table 8-3 from Amended ROD [Navy, 2009]) through the domestic use pathway (for example, drinking water or showering).	MNA	B-1 and B-2	MNA of groundwater to monitor VOC attenuation. Although exceedances of the VC and TCE RGs have occurred, VOC concentrations are within historical ranges for all monitoring wells, and the presence of VC demonstrates that TCE biodegradation is occurring in groundwater in Parcel B-1. VOCs in Parcel B-2 are consistently less than RGs.	
Groundwater			3. Prevent or minimize exposure of construction workers to metals, VOCs, and SVOCs in the A-aquifer groundwater at concentrations above remediation goals from dermal exposure and inhalation of vapors from groundwater (Table 8-3 from Amended ROD [Navy, 2009]).	ICs	All	ICs to prohibit the use of groundwater and installation of new groundwater wells for domestic purposes	ICs restrict land-disturbing activity unless prior written approval is granted by the FFA signatories (and CDPH at IR-07/18).
				ICs	All		

Table 3-3. Parcel B Remedial Action Summary and Expected Outcomes

Media	Risk/Basis for Action	Reasonably Anticipated Land Use	RAO	Remedy Component	Parcel ^a	Performance Metric	Expected Outcome
Groundwater	Ecological: Potential migration pathway of metals to surface water	Current use: Limited access unoccupied and unused buildings, few commercial buildings Planned future Use: Predominantly residential and shoreline open space	4. Prevent or minimize migration to the surface water of San Francisco Bay of chromium VI, copper, lead, and mercury in the A-aquifer groundwater that would result in concentrations of chromium VI above 50 µg/L, copper above 28.04 µg/L, lead above 14.44 µg/L, and mercury above 0.6 µg/L in the surface water of San Francisco Bay. This RAO is intended to protect the beneficial uses of the bay, including ecological receptors.	LTM	All	LTM of groundwater in wells installed near the bay to monitor metals concentrations in groundwater and to verify that metals concentrations in groundwater do not exceed TLs that might pose a risk to the San Francisco Bay if mobilized from redevelopment actions. IR-07/18: Concentrations of metals do not exceed TLs. Parcel B-1: Concentrations of metals do not exceed TLs. Parcel B-2: Concentrations of dissolved mercury exceed TLs.	Land suitable for planned future use compatible with durable covers and ICs as required by the LUC RD.
			1. Prevent exposure to radionuclides of concern in concentrations that exceed remediation goals (Table 8-4 from Amended ROD [Navy, 2009]) for the ingestion or inhalation exposure pathways.	Survey, Decontamination, and Removal of Radiologically Impacted Structures and Soil Surface Scan for Radiological Materials and Excavation and Disposal of Radiological Anomalies	B-1 and B-2	Identification and removal of historical subsurface storm drain and sanitary sewer utilities and screening and remediation of buildings, former building sites, and discharge channel as part of the TCRA for radionuclides. Radiological retesting is currently being conducted to confirm site conditions are compliant with the RAO. MARSSIM Class 1 Survey of the entire surface of IR-07/18 was completed. Soil, sediment, and debris that exceeded release criteria or was assumed to be LLRW was removed.	
Radiologically Impacted Soil and Structures	Human Health: Radiological risks for soil and structures (storm drains, sanitary sewers, buildings) were greater than 10 ⁻⁶ .			Durable Cover with Demarcation Layer	IR-07/18	Durable covers provide physical barriers to prevent exposure of humans and wildlife to potential ROCs. The demarcation layer within the cover over potentially radiologically impacted areas serves as a warning against digging into potentially contaminated soil. Covers are inspected and maintained to prevent exposure to COCs.	
				LTM	IR-07/18	Groundwater LTM to monitor potential ROC concentrations. Since at least 2009, concentrations of potential ROCs have remained less than TLs.	
				ICs	IR-07/18	ICs to prohibit excavation below the demarcation layer unless prior written approval is granted by the FFA signatories and CDPH (ERRG, 2012b).	

Table 3-3. Parcel B Remedial Action Summary and Expected Outcomes

References:	
Department of the Navy (Navy). 1997. <i>Hunters Point Shipyard, Parcel B, Final Record of Decision</i> . Engineering Field Activity West, Naval Facilities Engineering Command. October 7.	
Navy. 2009. <i>Amended Parcel B Record of Decision, Hunters Point Naval Shipyard, San Francisco, CA</i> . Final. January 14.	
ERRG. 2012b. <i>Operation and Maintenance Plan for Installation Restoration Sites 07 and 18 in Parcel B, Hunters Point Naval Shipyard, San Francisco, California</i> . Final. October.	
^a IR-07/18, Parcel B-1, and Parcel B-2 were included in a single ROD/Amended ROD (Navy, 1997, 2009) for former Parcel B; however, the remedy components associated with a number of RAOs was specific to a site or parcel as noted in the Parcel column.	
µg/L = microgram(s) per liter	
ARIC = area requiring institutional controls	
CDPH = California Department of Public Health	
COC = chemical of concern	
FFA = Federal Facilities Agreement	
HHRA = human health risk assessment	
IC = institutional control	
LLRW = Low-level radiological waste	
LTM = long-term monitoring	
LUC = land use control	
MARSSIM = Multi-Agency Radiation Survey and Site Investigation Manual	
PAH = polycyclic aromatic hydrocarbon	
PCB = polychlorinated biphenyl	
RAO = remedial action objective	
RD = remedial design	
RG = remediation goal	
ROC = radionuclide of concern	
ROD = Record of Decision	
SGAL = soil gas action level	
SVE = soil vapor extraction	
SVOC = semivolatile organic compound	
TCE = trichloroethene	
TCRA = time-critical removal action	
TL = trigger level	
VC = vinyl chloride	
VOC = volatile organic compound	

Table 3-4. Comparison of Groundwater and Surface Water Quality Parameters

Location	Temperature (°C) – Bay Avg 12 to 16 °C			DO (mg/L) – Bay DO 8.0 to 8.3 mg/L		
	Minimum	Maximum	Average	Minimum	Maximum	Average
IR26MW49A	17	20.38	18.9	2.4	6.31	4.068
IR26MW50A	18	23.02	20.3	0.4	3.97	2.046
IR26MW51A	17.3	23.52	19.7	0	6.82	2.266
IR26MW70A	18.3	21.9	19.7	0	5.71	1.35
IR26MW71A	16.7	25.51	20.1	0.5	5.98	2.516

Notes:

Data collected during post-in situ stabilization monitoring in 9/2017, 3/2018, 6/2018, 9/2018, 12/2018

References:

KMEA MACTEC Joint Venture (KMJV). 2021. Remedial Action Construction Summary Report, Parcel B-2, Installation Restoration Site 26 Groundwater Treatment, Former Hunters Point Naval Shipyard, San Francisco, California. December 9.

Osborn, Liz. 2024. "Average Ocean Water Temperatures at San Francisco." CurrentResults.com. <https://www.currentresults.com/Oceans/Temperature/san-francisco-average-water-temperature.php>.

Schraga, T.S., E.S. Nejad, C.A. Martin, and J.E. Cloern. 2023. USGS Measurements of Water Quality in San Francisco Bay (CA), 2016-2021. U.S. Geological Survey data release. Version 4. March. <https://www.sciencebase.gov/catalog/item/5966abe6e4b0d1f9f05cf551>.

°C = degree(s) Celsius
DO = dissolved oxygen
mg/L = milligram(s) per liter

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Table 3-5. Fourth Five-Year Review Parcel B Issues, Recommendations, and Follow-up Actions

Parcel/Site	Fourth Five-Year Review Protectiveness	Issue	Recommendation (Milestone)	Date Complete/Current Status
B-1	Will be protective	SVE implementation in Parcels B-1 and C is reducing source mass, but with limited effectiveness due to diffusion-limited conditions in the subsurface. Although ICs will maintain future protectiveness, source-removal inefficiency is extending the period within which SVE will be implemented.	It is recommended that use of the SVE technology be evaluated for each treatment area due to inefficiency caused by diffusion-limited conditions. Site-specific studies (e.g., remedy analyses) should be performed to estimate the magnitude and extent of source mass at each treatment area in Parcels B-1 and C to determine if other measures could be implemented to enhance SVE performance in the future. Any changes implemented to the approach for reducing source contamination in SVE areas should be discussed in the next Five-Year Review report. Changes made to the treatment approach should be considered for any other SVE treatment areas at HPNS, including areas where treatment is planned but has not yet been initiated. (12/31/2019)	Completed February 2021. The system was operated most recently from October 2019 to April 2020, resulting in the removal of 1.4 pounds of TCE. Post-SVE shutdown rebound monitoring demonstrated that the SVE system reached a point of diminishing returns (Navy, 2019, Inovex-ERRG Joint Venture, 2021). Therefore, soil excavation and subsequent confirmation monitoring is planned for IR-10 to address VOC soil contamination to a depth of 10 feet bgs (Insight-ESI, 2023).
B-1, B-2	Will be protective	The regulatory agencies do not agree with the Navy's risk assessment methodology used to reduce the ARICs for VOC vapors.	The Navy intends to consider agency concerns (including specific recommendations made by USEPA) and reevaluate its approach to calculating SGALs, which may affect the ARICs for VOC vapors at Parcels B-1, B-2, D-1, and G. Appendix E (of the Fourth Five-Year Review) evaluated how USEPA's recommendations may affect the SGALs and the ARICs for VOC vapors. Based on the information in Appendix E, none of the potential changes to the ARICs for VOC vapors affect the current protectiveness of the remedies at Parcels B-1, B-2, D-1, and G. The regulatory agencies are currently reviewing and re-evaluating their methods for assessing vapor intrusion risk. Once consensus is achieved, the Navy should reevaluate its approach for calculating SGALs and adjusting ARICs for VOC vapors. The new SGALs would be developed based on the most current standards, toxicity criteria, and risk assessment methods. The new SGALs would be used to redefine the ARICs for soil gas at each parcel prior to property transfer. Any changes to soil gas risk assessment methodology should be discussed in the next Five-Year Review report. (12/31/2019)	In progress. The work plan was finalized in September 2023 and excavation fieldwork is currently underway and will be completed in fall 2024 followed by a year of quarterly soil gas monitoring. A remedial action is currently being planned to address VOCs at Building 123, Site 10 (within Parcel B-1). A dual tracking approach is being used to evaluate methods to calculate SGALs for the removal which includes Method 1: Federal Toxicity Criteria Hierarchy (USEPA, 2003) and Method 2: State of California Toxicity Criteria Hierarchy using DTSC toxicity criteria for human health risk assessments. The Navy will evaluate differences between the Method 1 and Method 2 risk estimates in the risk characterization. The Navy will also discuss results of the risk characterization and its recommendations for updating VI areas requiring ICs with the BCT prior to submitting the draft RACR for BCT review (Insight-ESI, 2023). While there is disagreement about the method to calculate the SGALs which may affect ARIC boundaries, the final ARICs that will be surveyed and recorded in quietclaim deeds and covenants to restrict land use will be established in agreement with the BCT. Because attenuation of VOCs is likely to occur, ARICs for VOC vapors, and likewise SGALs that are the basis of the ARICs, in Parcels B-1 and B-2 will be re-evaluated and finalized during preparation for property transfer. Protectiveness is not affected because the Navy currently controls the property and land use, and future protectiveness will not be affected because the ARICs will be established in the appropriate legal documentation.
B-1, B-2	Will be protective	The Navy has determined that a significant portion of the radiological survey and remediation work completed to date was not reliable because of manipulation or falsification of data by one of its radiological contractors. A long-term protectiveness evaluation of the radiological RGs has not yet been completed for the Fourth Five-Year Review, and it is currently not known if the RAOs for radionuclides have been achieved in Parcels B-1, B-2, C, D-1, D-2, G, E, UC-1, UC-2, and UC-3.	See Section 1.4.3 for the long-term protectiveness evaluation component of this recommendation. The Navy is in the process of implementing corrective actions to ensure that the radiological remedies specified in the decision documents are implemented as intended. It is anticipated that the radiological rework will be completed prior to the next Five-Year Review.	Long-term Protectiveness Evaluation: Completed June 2020. Addenda to the Fourth Five-Year Review were prepared to evaluate the Radiological RGs for soil and buildings. The conclusions of both reports were that the current RGs were protective of human health and the environment (Navy, 2020a, 2020b). In Progress. Planning for the radiological retesting of soil and surveys of building and former building structures at Parcel B (including Parcels B-1 and B-2) was initiated in February 2019. Fieldwork activities were initiated in fall 2022. Upon completion, radiological rework will be summarized in a RACR anticipated to be completed in 2025.

Table 3-5. Fourth Five-Year Review Parcel B Issues, Recommendations, and Follow-up Actions

References:	
Department of the Navy (Navy). 2019. <i>Fourth Five-Year Review, Hunters Point Naval Shipyard, San Francisco, California</i> . July.	
Innovex-ERRG Joint Venture. 2021. <i>SVE System Operation, Maintenance, and Monitoring Status Update for October 2019-September 2020 Operating Period, IR-10 Carveout, Parcel B-1, Hunters Point Naval Shipyard, San Francisco, California</i> . Final. February 1.	
Insight-ESI, LLC (Insight-ESI). 2023. <i>Remedial Action Work Plan, Parcel B-1, Installation Restoration Site 10, Building 123, Hunters Point Naval Shipyard, San Francisco, California</i> . Final. September.	
Navy. 2020a. <i>Addendum to the Five-Year Review, Evaluation of Radiological Remedial Goals for Soil, Hunters Point Naval Shipyard, San Francisco, California</i> . June 18.	
Navy. 2020b. <i>Addendum to the Five-Year Review, Evaluation of Radiological Remedial Goals for Building Structures, Hunters Point Naval Shipyard, San Francisco, CA</i> . June 18.	
ARIC = area requiring institutional controls	RACR = Remedial Action Completion Report
BCT = BRAC Cleanup Team	RG = remediation goal
bgs = below ground surface	SGAL = soil gas action level
BRAC = Base Realignment and Closure	SVE = soil vapor extraction
DTSC = California Department of Toxic Substances Control	TCE = trichloroethene
HPNS = Hunters Point Naval Shipyard	USEPA = United States Environmental Protection Agency
IC = institutional control	VI = vapor intrusion
Navy = Department of the Navy	VOC = volatile organic compound

Table 3-6. Parcel B Chemicals of Concern and Current Comparison Criteria for Groundwater

Exposure Medium	Exposure Scenario	Chemical of Concern	Values from Amended ROD		Current Comparison Criteria				
			Amended ROD Remediation Goal (2009)	Source of Remediation Goal	11/2022 USEPA RSL or VISL ^a	Basis of RSL or VISL (C/N/C)	DTSC-SL	California MCL	USEPA MCL
Groundwater A-Aquifer (µg/L)	Residential Vapor Intrusion	1,2,4-Trichlorobenzene	66	RBC	35.9	NC	NA	5	70
		1,2,4-Trimethylbenzene	25	RBC	248	NC	NA	None	None
		1,2-Dichlorobenzene	2,561	RBC	2660	NC	NA	600	600
		1,2-Dichloroethane	2.3	RBC	2.24	C	NA	0.5	5
		1,2-Dichloroethene (total)	209	RBC	109	NC	NA	6 / 10	70 / 100
		1,2-Dichloropropane	1.1	RBC	6.58	C	NA	5	5
		1,3,5-Trimethylbenzene	19	RBC	175	NC	NA	None	None
		1,4-Dichlorobenzene	2.1	RBC	2.59	C	NA	5	75
		2-Methylnaphthalene	707	RBC	NITD		NA	None	None
		Benzene	0.5	PQL	1.59	C	NA	1	5
		Bromodichloromethane	1	RBC	0.876	C	NA	80	80
		Chlorobenzene	392	RBC	410	NC	NA	70	100
		Chloroethane	6.5	RBC	9190	NC	NA	None	None
		Chloroform	1	PQL	0.814	C	NA	80	80
		cis-1,2-Dichloroethene	209	RBC	250	NC	NA	6	70
		Dichlorodifluoromethane	14	RBC	7.44	NC	NA	None	None
		Mercury	0.68	RBC	0.889	NC	NA	2	2
		Methylene chloride	27	RBC	763	C	NA	5	5
		Naphthalene	3.6	RBC	4.59	C	NA	None	None
		Tetrachloroethene	1	PQL	14.9	C	NA	5	5
	trans-1,2-Dichloroethene	182	RBC	109	NC	NA	10	100	
Trichloroethene	2.9	RBC	1.19	C	NA	5	5		
Trichlorofluoromethane	176	RBC	NITD		NA	150	None		
Vinyl chloride	0.5	PQL	0.147	C	NA	0.5	2		
		Chloroform	1.2	RBC	3.55	C	NA	80	
	Industrial Vapor Intrusion								

Table 3-6. Parcel B Chemicals of Concern and Current Comparison Criteria for Groundwater

Exposure Medium	Exposure Scenario	Chemical of Concern	Values from Amended ROD		Current Comparison Criteria				
			Amended ROD Remediation Goal (2009)	Source of Remediation Goal	11/2022 USEPA RSL or VISL ^a	Basis of RSL or VISL (C/NC)	DTSC-SL	California MCL	USEPA MCL
Groundwater B-Aquifer (µg/L)	Residential Domestic Use	1,4-Dichlorobenzene	7.5	ARAR	0.48	C	No value	5	75
		Antimony	43.26	HGAL	7.8	NC	No value	6	6
		Arsenic	27.34	HGAL	0.052	C	0.0082	10	10
		Benzene	5	ARAR	0.46	C	0.15	1	5
		Chloroethane	4.6	RBC	8300	NC	No value	None	None
		Manganese	8,140	HGAL	430	NC	No value	None	None
		Pentachlorophenol	25	PQL	0.041	C	No value	1	1
		Thallium	12.97	HGAL	0.2	NC	0.59	2	2
		Trichloroethene	5	ARAR	0.49	C	No value	5	5

^a VISL presented for A-aquifer groundwater, RSL for all other media and groundwater aquifers.**Notes:**

Shading indicates current comparison criteria is lower than Amended ROD Remediation Goal unless Remediation Goal is Background.

µg/L = microgram(s) per liter

ARAR = applicable or relevant and appropriate requirement

C = carcinogen

DTSC = California Department of Toxic Substances Control

HGAL = Hunters Point groundwater ambient level

MCL = maximum contaminant level

mg/kg = milligram(s) per kilogram

NA = not available

NC = noncarcinogen

PQL = practical quantitation limit

RBC = risk-based concentration

ROD = Record of Decision

RSL = regional screening level

SL = screening level

USEPA = U.S. Environmental Protection Agency

VISL = vapor intrusion screening level

Table 3-7. Parcel B Chemicals of Concern for Ecological Receptors - Sediment

Exposure Medium	Exposure Scenario	Chemical of Concern	Amended ROD Remediation Goal (2009)	Source of Remediation Goal/Target Level	Receptor Basis	Toxicity Value Used as Source of Remediation Goal	Changes in Exposure Factors?	Changes in Toxicity Values?	Remediation Goal Still Protective?
Sediment (mg/kg)	Ecological Receptor	Aluminum	3,400	RBC	Small Mammals	Sample et al., 1996	No	TRV scaling is no longer used. Sample et al. (1996) is still used.	Yes. Changes to toxicity values would not alter the overall conclusion of the risk assessment or significantly alter the derivation of RBCs. RG is still protective.
		Copper	270	RBC	Benthic macroinvertebrates	ERM	No	No	Yes. Source of benchmark used as RG is still in use today.
		Dibenz(a,h)anthracene	0.33	PQL	Benthic macroinvertebrates	ERM	No	No	Yes. Source of the RG is the PQL. Analyte was only identified as a COC for subsurface sediments (2.5 to 4 feet bgs) which are not in the biologically active zone.
		Dieldrin	0.008	RBC	Benthic macroinvertebrates	ERM	No	No	Yes. Source of benchmark used as RG is still in use today.
		Lead	218	RBC	Benthic macroinvertebrates	ERM	No	No	Yes. Source of benchmark used as RG is still in use today.
		Methoxychlor	0.4	RBC	Birds	BTAG TRVs for DDT	No	TRV scaling is no longer used. Bird TRVs are available for methoxychlor in LANL (2022) and are less conservative (higher) than those from BTAG.	Yes. TRVs used to derive the RG are more conservative than TRVs commonly used today. RG is overprotective.
		Total Aroclors	0.18	RBC	Benthic macroinvertebrates	ERM	No	No	Yes. Source of benchmark used as RG is still in use today.
		Total DDT	0.046	RBC	Benthic macroinvertebrates	ERM	No	No	Yes. Source of benchmark used as RG is still in use today.
		Zinc	410	RBC	Benthic macroinvertebrates	ERM	No	No	Yes. Source of benchmark used as RG is still in use today.

Reference:

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. ES/ERTM-86/R3. ORNL, Oak Ridge, Tennessee.

Los Alamos National Laboratory (LANL). 2022. EcoRisk database. Release 4.2. November.

bgs = below ground surface

BTAG = Biological Technical Assistance Group

COC = chemical of concern

DDT = dichlorodiphenyltrichloroethane

ERM = effects range median

LANL = Los Alamos National Laboratory

mg/kg = milligram(s) per kilogram

PQL = practical quantitation limit

RG = risk-based concentration

ROD = Record of Decision

TRV = toxicity reference value

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Table 3-8. Parcel B Chemicals of Potential Concern for Ecological Receptors - Groundwater

Exposure Medium	Exposure Scenario	Chemical of Concern	Amended ROD Trigger Level (2009)	Source of Trigger Level	Receptor Basis	NRWQC (2023)	Basin Plan SF Bay (2019)	Value Still Protective?	Notes
Groundwater (µg/L)	Ecological Receptor	Chromium VI	50	NRWQC - CCC	Aquatic Organisms	50	50	Yes	Analyte was not identified as posing potential risk to ecological receptors in the SLERA. It was included in the monitoring due to detections in well IR10MW12A/IR10MW82A. The TL is a risk-based criteria for surface water exposures but is not an ARAR for ecological exposure to groundwater.
		Copper	28.04	HGAL	Aquatic Organisms	3.1	6	Yes	Analyte was not identified as posing potential risk to ecological receptors in the SLERA due to low FOD and no defined plume. However, it was included in the monitoring plan. The TL is based on ambient levels and is not a risk-based value. Risk-based criteria for surface water (NRWQC and Basin Plan) are for comparison purposes only and are not ARARs for groundwater exposures.
		Lead	14.44	HGAL	Aquatic Organisms	8.1	8.1	Yes	Analyte was not identified as posing potential risk to ecological receptors in the SLERA due to low FOD and no defined plume. However, it was included in the monitoring plan. The TL is based on ambient levels and is not a risk-based value. Risk-based criteria for surface water (NRWQC and Basin Plan) are for comparison purposes only and are not ARARs for groundwater exposures.
Groundwater (µg/L)	Ecological Receptor	Mercury	0.6	HGAL	Aquatic Organisms	0.94 (D)	0.03 mg/kg fish tissue	Yes	Detected in well IR26MW47A/49A greater than TL. Assumes aquatic receptors are exposed to full concentration detected in groundwater well. Potential for mixing is not accounted for in the comparisons with the TL. The TL is based on ambient levels and is not a risk-based value. Risk-based criteria for surface water (NRWQC and Basin Plan) are for comparison purposes only and are not ARARs for groundwater exposures. The 2019 update to the San Francisco Bay Basin Plan (2019) has revised the mercury goal to a tissue-based value.

Reference:

San Francisco Bay Region Water Quality Control Board (SFRWQCB). 2019. San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan). California Regional Water Quality Control Board – San Francisco Bay Region . November.

µg/L = microgram(s) per liter

ARAR = applicable or relevant and appropriate requirement

CCC = criterion continuous concentration

(D) = dissolved

FOD = frequency of detection

HGAL = Hunters Point groundwater ambient level

mg/kg = milligram(s) per kilogram

NRWQC = National Recommended Water Quality Criteria

ROD = Record of Decision

SLERA = screening-level ecological risk assessment

TL = trigger level

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Table 3-9. Parcel B Issues, Recommendations, and Follow-up Actions

Parcel	Issue	Recommendations/ Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
B-1 B-2	As identified in the Fourth Five-Year Review, there is uncertainty with a portion of the radiological survey and remediation work performed between 2004 and 2016 under the Basewide Radiological Removal Action, Action Memorandum (Navy, 2006). The Navy is in the process of implementing corrective actions to ensure the radiological remedies specified in the decision documents were implemented as intended; however, this work is ongoing.	Complete radiological retesting at radiologically impacted sites, including current and former buildings and soil areas investigated under the Radiological Removal Action, Action Memorandum (Navy, 2006) and areas where evaluations determined previous data were unreliable.	Navy	USEPA	2/27/2025	N	Y
B-2	The in-situ stabilization remedy for mercury in Parcel B-2, IR-26 groundwater did not reduce concentrations to below the 0.6 µg/L trigger level and there is uncertainty related to the concentrations of mercury potentially discharging to the Bay from Parcel B-2, IR-26 groundwater.	1. Prepare a primary document evaluating technologies for treating mercury in groundwater and presenting a proposed treatment method for FFA regulatory agency review. 2. Apply the selected method that is within compliance of the selected remedy in the record of decision and initiate performance monitoring.	Navy	USEPA	10/31/2024	Protectiveness Deferred	
			Navy	USEPA	7/15/2025		

Source: Navy. 2006. *Base-wide Radiological Removal Action, Action Memorandum – Revision 2006*, Hunters Point Shipyard, San Francisco, California. Final. April 21.

Navy = Department of the Navy

USEPA = United States Environmental Protection Agency

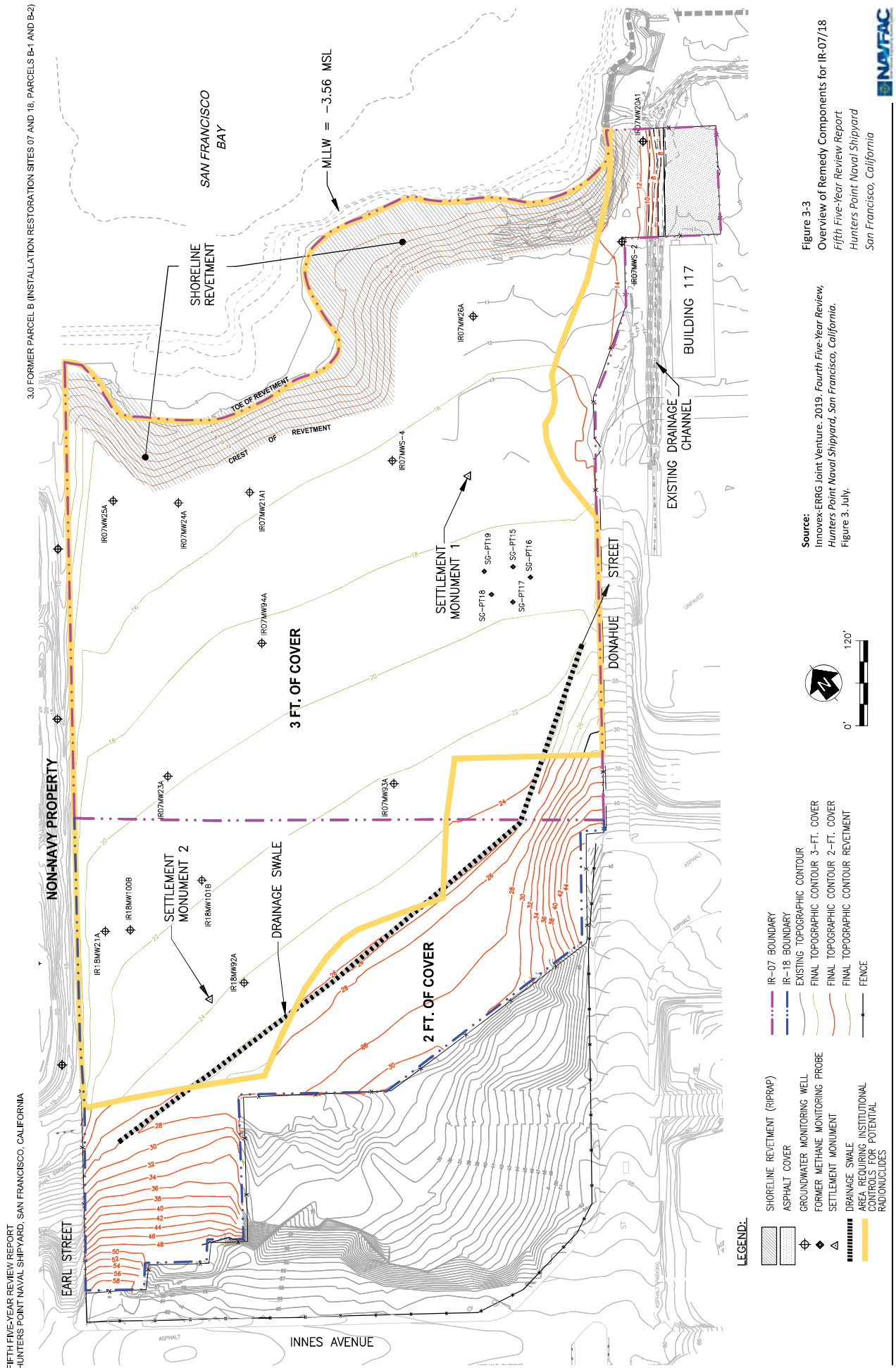
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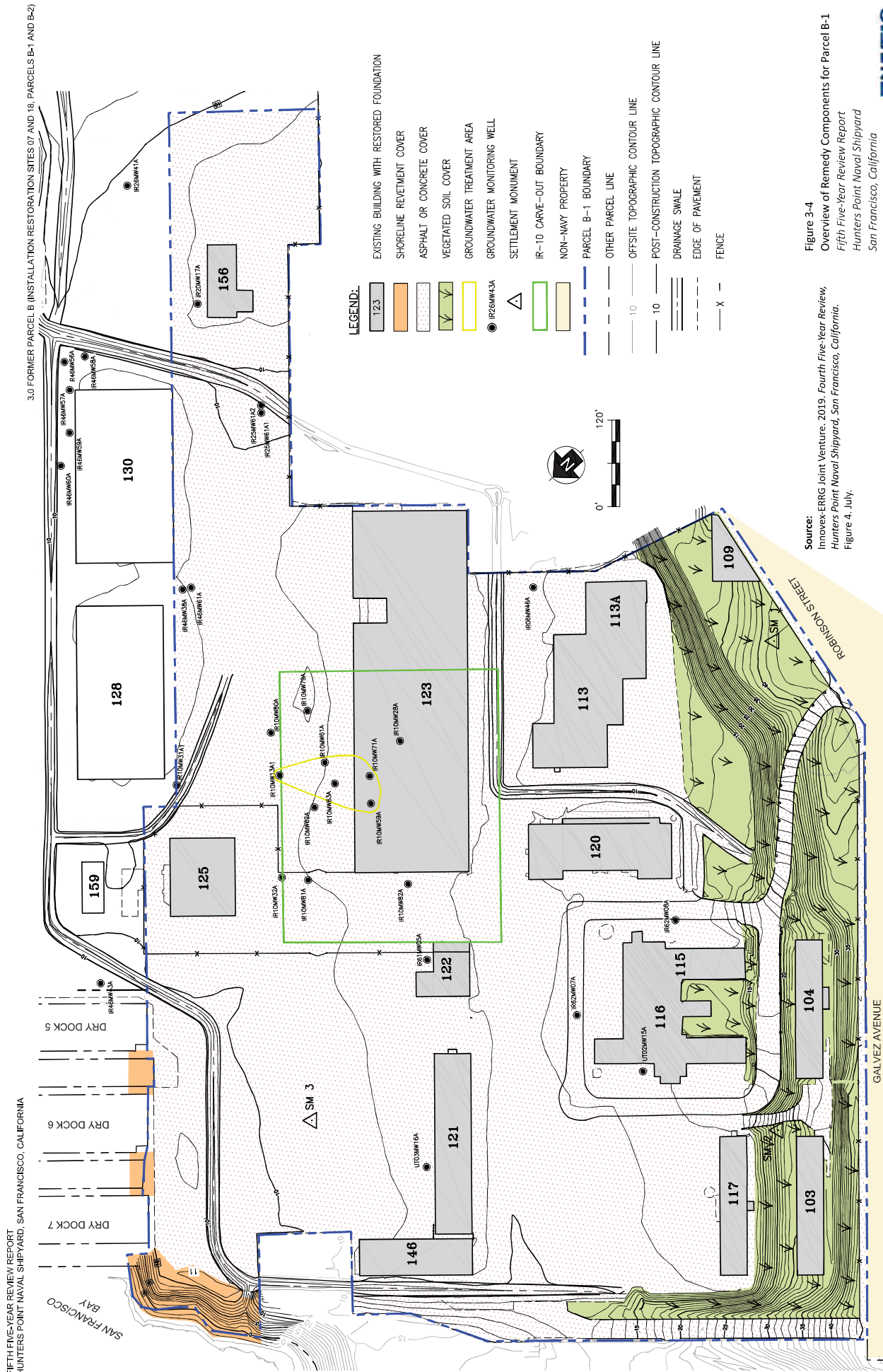
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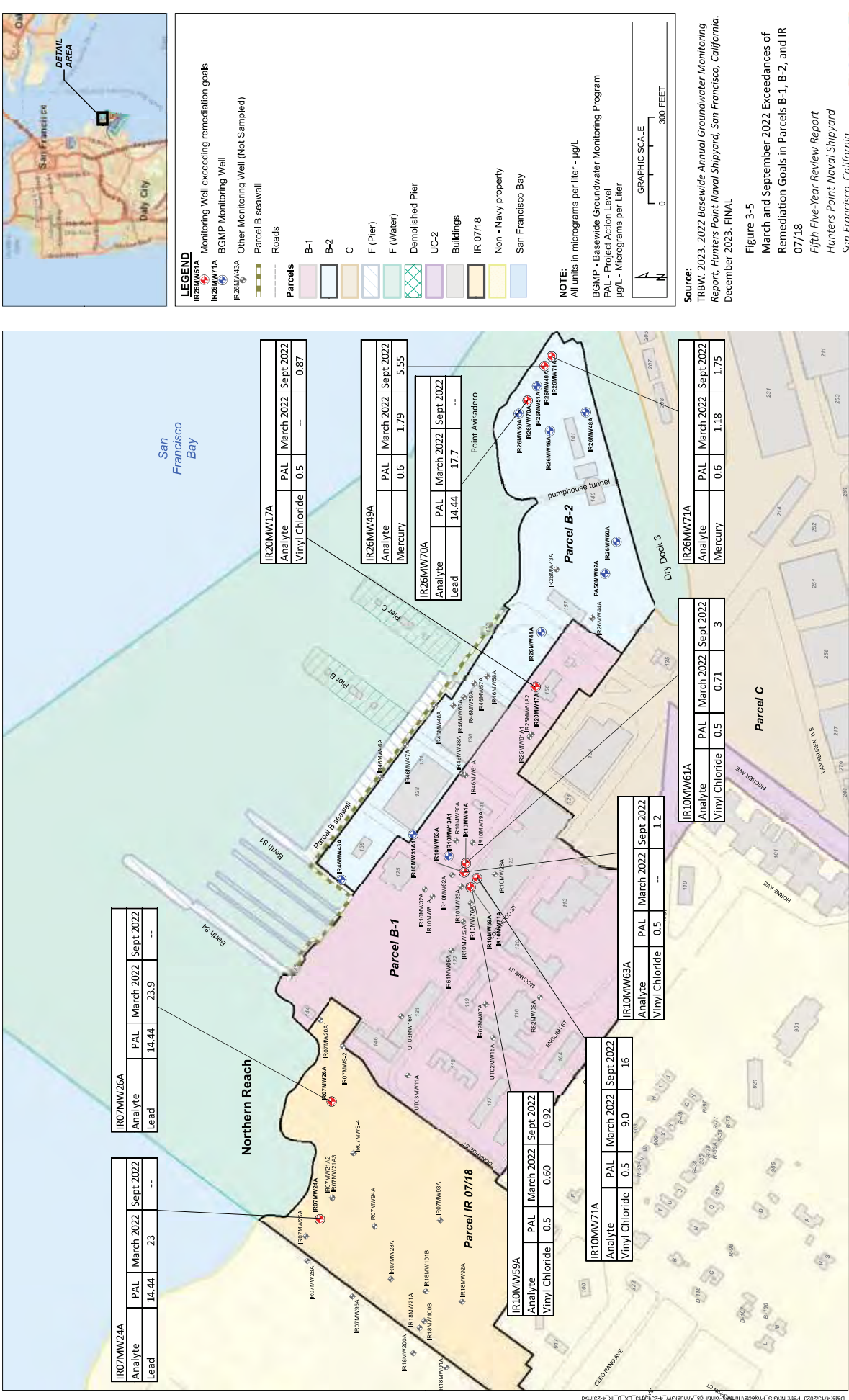


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3.0 FORMER PARCEL B (INSTALLATION RESTORATION SITES 07 AND 18, PARCELS B-1 AND B-2)



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3.0 FORMER PARCEL B (INSTALLATION RESTORATION SITES 07 AND 18, PARCELS B-1 AND B-2)

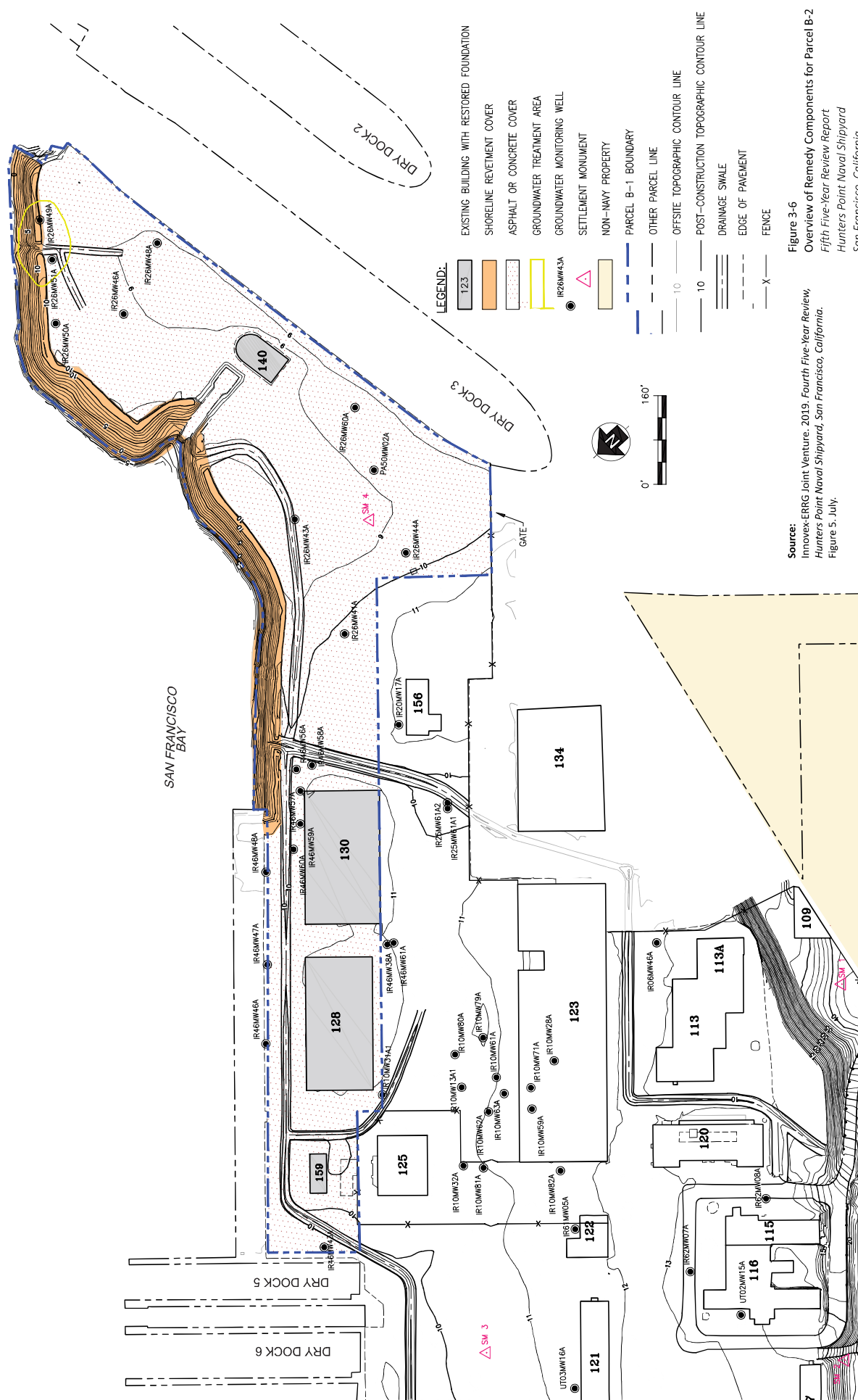
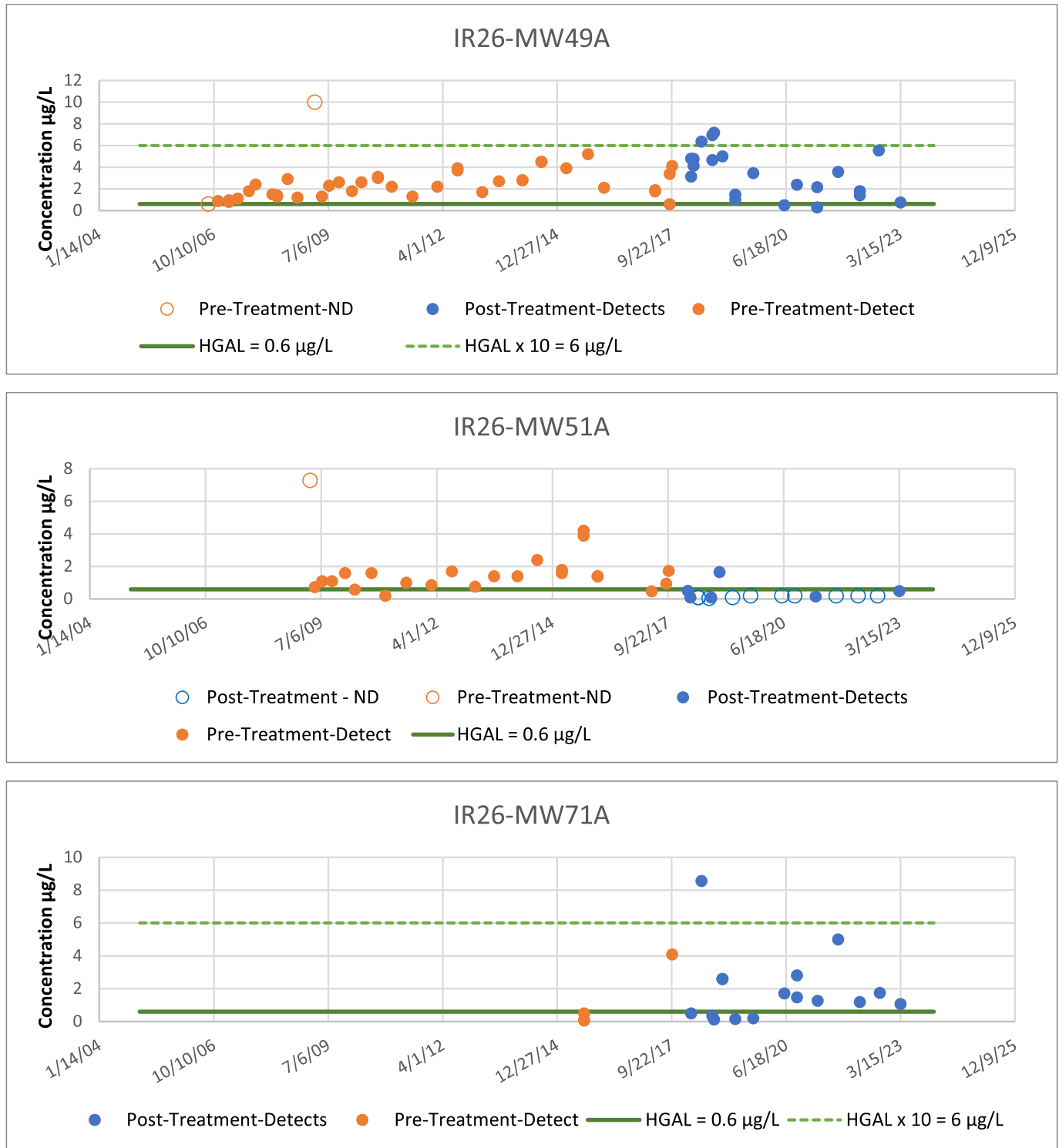


Figure 3-6
Overview of Remedy Components for Parcel B-2
Fifth Five-Year Review Report
Hunters Point Naval Shipyard
San Francisco, California

Source:
Innovex-ERRG Joint Venture, 2019, Fourth Five-Year Review,
Hunters Point Naval Shipyard, San Francisco, California.
Figure 5, July.

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Time-series Plots for Mercury in IR-26 Groundwater

Fifth Five-Year Review
Hunters Point Naval Shipyard
San Francisco, California



Figure 3-7

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4.0 Former Parcel C (Parcels C and UC-2)

4.1 Site History and Background

Former Parcel C is the oldest portion of the shipyard and was used almost exclusively for industrial purposes since the late 1800s. The central portion of the shipyard was formerly part of the industrial support area and was used for shipping, ship repair, and office and commercial activities. NRDL used portions of Parcel C.

Former Parcel C is bounded by Former Parcel B to the north, Parcel A to the west, Former Parcel D to the south, and the San Francisco Bay to the east. Former Parcel C covered approximately 79 acres, which was subdivided into two parcels in 2008: Parcel C (73 acres) and Parcel UC-2 (3.9 acres) (**Figure 4-1**).

The following IR sites are located in Parcels C and UC-2:

- Parcel C: IR-06 (partial), IR-25, IR-27, IR-28, IR-29, IR-30, IR-57, IR-58, IR-63, and IR-64
- Parcel UC-2: IR-06 (partial)

Four IR sites (IR-45, IR-49, IR-50, and IR-51) are facility-wide utilities that cut across other IR sites or are the locations of former transformer storage areas. Investigations at Parcels C and UC-2 began in 1994 as shown in the following chronology.

Parcel C Chronology	
Date	Investigation/Action
1994	SI
3/1997	RI
1996–1997	Exploratory Excavation Removal Action
1996–1997	Storm Drain Sediment Removal
1996–1998	FS (initial phase)
7/1998–9/1999	Soil Removals at IR-06 and IR-25
1999	Risk Management Review
4/2001	Groundwater Treatability Study at Building 253
2000–2002	Fuel and Steam Line TCRA
2001–2002	SVE Treatability Studies
9/2002	Groundwater Treatability Study at Building 272
2002–2004	Waste Consolidation and Removal Activities
2003	Encapsulation of Drainage Culvert Sediment at Dry Dock 4
2004	Degreaser Pit/Separator Demolition at RU-C5 HRA
2004–Ongoing	Groundwater Monitoring under the BGMP

Parcel C Chronology	
Date	Investigation/Action
2004–2005	Groundwater Treatability Study at Building 134 Follow-on Groundwater Treatability Study at Building 272
2008	Revised FS
12/2009	Parcel UC-2 ROD
2009–2010	Groundwater Treatability Study at Building 253
2010–2011	Groundwater Treatability Study at Building 134
9/2010	Parcel C ROD
2012	Pre-design Investigation RU-C2 RD for Parcel C Treatability Study RU-C5 Durable Cover installation Parcel UC-2
2013	RAWPs for Parcel C Third Five-Year Review for HPNS RACR for Durable Covers at UC-2
2013–2015	Soil Excavation and Disposal, Parcel C
2013–2018	SVE System Operation, Parcel C
2013–Ongoing	Groundwater Remediation and Performance Monitoring
10/2014	ESD to the Final ROD for Parcel C
2015	Transfer of Parcel UC-2 to the City and County of San Francisco's OCII
2015–2016	Durable Cover Installation, Parcel C
2017	RACR for Durable Covers in Parcel C
2019	Fourth Five-Year Review for HPNS
2019	Groundwater remediation in RU-C1 and RU-C2
2021	Groundwater remediation in RU-C4
2022–Ongoing	Radiological Retesting Fieldwork Parcel C

4.2 Site Characterization

This section summarizes the findings from various investigations at Parcels C and UC-2 that are pertinent to the Five-Year Review.

4.2.1 Physical Characteristics

4.2.1.1 Surface Features

Parcel C is located in the lowlands portion of HPNS, and ground surface elevations generally range from 0 to 10 feet above msl. More than 90 percent of Parcel C is covered by pavement

and former industrial buildings. The area surrounding and adjacent to Dry Dock 2 and Dry Dock 3 was identified as the Hunters Point Commercial Dry Docks Historical District.

Surface water runoff was historically collected in the storm drain system and discharged to the bay through outfalls. However, the storm drains and sewer lines were removed during ongoing radiological investigations, and surface drainage swales redirect stormwater to San Francisco Bay.

4.2.1.2 Geology and Hydrogeology

The western portion of Parcel C contains native soil over shallow bedrock, whereas most of the parcel consists of flat lowlands. The lowlands were constructed by placing borrowed fill material from various sources, including crushed serpentinite bedrock from the adjacent highland, construction debris, and waste materials (such as used sandblast materials). The serpentinite bedrock and serpentine bedrock-derived fill material consist of minerals that naturally contain asbestos and relatively high concentrations of arsenic, manganese, nickel, and other ubiquitous metals.

The following is a summary of hydrostratigraphic units at Parcel C (SulTech, 2008; ECC-Insight, 2019):

- **A-Aquifer:** Depth to the top of the A-aquifer occurs at approximately 8 to 10 feet bgs across most of Parcels C and UC-2. Groundwater flows to the southeast or northeast, directly toward the bay or dry dock, at bayside perimeter locations of the parcels. The A-aquifer averages between 20 and 25 feet thick over most of Parcels C and UC-2. Tidal fluctuations were observed from 150 to 500 feet inland from the bay.
- **Bay Mud:** The Bay Mud is present at Parcels C and UC-2. It generally thickens from 0 feet in the southwest to 40 feet in the northeast. A 5- to 12-foot-thick Sandy Lean Clay layer was identified in borings advanced during previous investigations within the RU-C2 area, which also acts as an aquitard separating the A- and B-aquifers when Bay Mud is absent (ECC-Insight, 2019).
- **B-Aquifer:** The B-aquifer is present over an area of approximately 22 acres, or about 28 percent of Parcel C, in the east-central area. It is semiconfined by Bay Mud and Sandy Lean Clay (ECC-Insight, 2019). It is not present at Parcel UC-2. Groundwater elevations range from 1 foot below msl in the eastern portion of Parcel C during spring and summer to 4 to 5 feet above msl in the western portion of the parcel (TRBW, 2023). Groundwater flows generally to the southeast.
- **Fractured Water-bearing Zone (F-WBZ):** The water table is present within the saturated F-WBZ over approximately 30 acres (38 percent) of Parcel C.

As discussed in **Section 1.3.4.3**, the entire A-aquifer and the B-aquifer within Parcel C, with the exception of a small portion of the B-aquifer associated with Parcel B (RU-5, in the area of Building 134), meets the Resolution 88-63 exception criteria. Similarly, the exception applies to F-WBZ where it is in direct contact with or hydrogeologically connected to the overlying A- and B-aquifers.

4.2.2 Land Use

4.2.2.1 Current Land Use

Parcel C is currently owned by the federal government and is under the jurisdiction of the Navy. There are no tenants at Parcel C.

Parcel UC-2 was transferred out of federal ownership to the City and County of San Francisco's OCII in late 2015 and is currently used as a roadway and utility corridor.

4.2.2.2 Future Land Use

According to the Redevelopment Plan (OCII, 2018), Parcel C land uses will include office and industrial, multi-media and digital arts, hotel, retail sales and services, residential (select areas; see redevelopment plan), civic, arts and entertainment, parks and recreation, and institutional uses. The area along the eastern portion of Parcel C bounded by the bay will be set aside for parks and open space.

4.2.3 Basis for Taking Action

This section describes the results of site investigations and risk assessments that provide the basis for taking action at Parcel C. Details are provided in the RI (PRC et al., 1997), FS (SulTech, 2008), Parcel C ROD (Navy, 2010) and ESD (Navy, 2014), and Parcel UC-2 ROD (Navy, 2009).

4.2.3.1 Site Investigations and Pre-ROD Removal Actions

Previous investigations at Parcel C identified metals, VOCs, PAHs, and PCBs in soil; VOCs, PAHs, SVOCs, and metals in groundwater; and radiologically impacted structures and soil. The Navy has currently defined four Rus for groundwater: RU-C1, RU-C2, RU-C4 (includes former RU-C3), and RU-C5. Rus consist of an area of a known source of contamination and the area of contaminated groundwater associated with that source.

The Navy has completed a number of removal actions and treatability studies at Parcel C. Two key soil removal actions reduced or eliminated certain risks to human health and ecological receptors. More than 3,000 samples were collected, and approximately 9,600 cubic yards of soil was excavated during the exploratory excavations and the steam and fuel lines TCRA. Past and ongoing treatability studies at Parcel C have focused on technologies to reduce VOCs in groundwater and soil, including zero-valent iron (ZVI) injection and sequential anaerobic or aerobic bioremediation. Based on these removal actions and studies, the sources and extent of the remaining contamination in soil and groundwater have been well characterized (Navy, 2010).

4.2.3.2 Human Health Risk

A quantitative HHRA was completed for Parcels C and UC-2 as part of the 1997 RI (PRC et al., 1997) and was updated in the 2008 FS (SulTech, 2008). Human health risks were characterized separately for COCs and ROCs. The RODs for Parcels C and UC-2 (Navy, 2010, 2009, respectively) identified the following unacceptable human health risks from nonradiological chemicals (**Table 4-1**):

- Future industrial users from exposure to metals, VOCs, and SVOCs in surface (0 to 2 feet bgs) and subsurface soil (0 to 10 feet bgs), and VOCs in groundwater (in A-aquifer through the vapor intrusion to indoor air pathway)
- Future recreational users from exposure to metals and SVOCs in surface soil (0 to 2 feet bgs)

- Future residents (adult and child) from exposure to metals, VOCs, SVOCs, pesticides, and PCBs in surface (0 to 2 feet bgs) and subsurface soil (0 to 10 feet bgs); VOCs in A-aquifer through the vapor intrusion to indoor air pathway; and metals, VOCs, SVOCs, and pesticides in B-aquifer through domestic use (in RU-C5 only)
- Future construction workers from exposure to metals, SVOCs, and PCBs in subsurface soil (0 to 10 feet bgs) and VOCs in groundwater (A-aquifer through direct exposure and VOCs in trenches)

Table 4-2 presents ROCs from radiologically impacted buildings, storm drains, sanitary sewers, and associated soil identified at Parcels C and UC-2 (Tetra Tech, 2008).

4.2.3.3 Ecological Risk

The Navy concluded in the RI (PRC et al., 1997) that limited viable habitat is available for terrestrial wildlife at Parcel C because most of the site is covered with pavement and most of the terrestrial component of the shoreline at Parcel C is paved. The tidal area associated with the shoreline is associated with Parcel F. Therefore, ecological risk associated with exposure to soil was not evaluated further in the FS.

The Navy completed a screening evaluation of surface water quality to assess potential exposure by aquatic wildlife to groundwater as it interacts with the surface water of San Francisco Bay. Results of the screening evaluation indicated two metals (chromium VI and zinc) in groundwater may pose a potential risk to aquatic wildlife. However, groundwater monitoring data indicate metals migrate at a much slower rate than groundwater flows; thus, discharge of metals to the bay is not imminent. **Table 4-1** presents chemicals of ecological concern (COECs) and TLs. It is necessary to monitor affected areas to determine whether the plume is migrating and whether it will discharge to the bay at concentrations that exceed surface water criteria.

No COECs were identified in UC-2 groundwater.

4.3 Remedial Action Objectives

In 2009, the Navy divided Parcel C into two new parcels: Parcels C and UC-2.

The ROD for Parcel C was signed on September 30, 2010 (Navy, 2010), and an ESD to modify removal action boundaries was signed in October 2014 (Navy, 2014). **Table 4-3** summarizes the basis for action, reasonably anticipated land use, RAOs, remedy components, performance metrics, and expected outcomes for Parcel C. The presence of VOCs in groundwater and soil may contribute to the presence of VOC in soil gas; therefore, the vapor intrusion pathway is included as a basis for action and development of RAOs.

The ROD for Parcel UC-2 was signed on December 17, 2009 (Navy, 2009). **Table 4-4** summarizes the basis for action, reasonably anticipated land use, RAOs, remedy components, performance metrics, and expected outcomes for Parcel UC-2. One overall remedy was selected for Parcels C and UC-2, but many actions in the overall remedy were not applicable to Parcel UC-2; **Table 4-4** presents only applicable components.

Tables 4-1 and **4-2** summarize the Navy-developed RGs to meet the RAOs for soil, groundwater, and radiologically impacted media. The Navy also developed TLs for use in monitoring concentrations of metals in groundwater, as summarized in **Table 4-1**, in the A-aquifer for the protection of the environment. The TLs are conservative, and exceedance of a TL does not necessarily indicate an immediate risk, given dilution and mixing with surface water;

nonetheless, a potential for ecological risk was identified if the metals in groundwater discharge undiluted to the bay.

4.4 Remedial Actions

4.4.1 Parcel C

The RA for Parcel C includes the following major components:

- Soil excavation and removal to address COC in soil
- Durable cover installation and maintenance to address COCs in soil
- SVE to address VOCs in soil gas
- In situ treatment to address VOCs and metals in groundwater
- Groundwater monitoring, including in situ treatment performance monitoring, LTM of metals, and MNA of VOCs
- Radiological surveys and remediation through soil excavation and removal of sanitary sewer and storm drain lines and through decontamination (and demolition/dismantling if necessary) buildings, structures, and former building sites
- ICs for soil, soil gas, and groundwater

Remedy components are shown on **Figure 4-1, 4-2, and 4-3.**

4.4.1.1 *Remedy Implementation*

Soil Excavation and Removal

An ESD was finalized in October 2014 documenting a change to the excavation boundaries based on a tiered action level approach to remove the highest concentrations of COCs and relying on durable covers and ICs to meet the soil RAOs (Navy, 2014). Between 2013 and 2015, approximately 28,261 bank cubic yards (BCY) of contaminated soil was excavated from 18 excavation areas within Parcel C (RU-C1, C4, and C5 and Building 241) and disposed of offsite (APTIM, 2018). Excavations were successfully completed to remove contaminated soil with concentrations 5 to 10 times greater than the RGs in accordance with the Final RAWP (CB&I, 2013). Excavations were backfilled with clean fill.

Although excavations within RU-C2 were completed, achievement of RGs was not documented (IGI, 2020); however, the excavated area is under durable cover as described in the following section, thereby preventing current and future exposure to contaminated soil.

Additional Soil and Source Excavation

Additional areas of soil excavation were identified during preparation of the RAWP for groundwater (ECC-Insight and CDM Smith, 2017). Pre-RA characterization was completed over two mobilizations between November 2017 and July 2018, and identified several significant changes to the RAWP, including the following:

- **RU-C1:** Based on groundwater concentrations in samples collected from monitoring well IR28MW557A, which exhibited high concentrations of VOCs, the suspected source (sumps within Building 253) was confirmed with the identification of dense nonaqueous phase liquid (DNAPL) in the center of the former paint room (within Building 253); consequently, excavation and removal of the sumps was not conducted (ECC-Insight, 2019). The Navy is

evaluating options to treat the DNAPL source area at Building 253 and, subsequently, the associated groundwater plume. This work is anticipated to begin in 2031.

- **RU-C2:** Soil concentrations in confirmation samples from excavation 20B-1 at Building 251 remained greater than RGs and are a continuing source to groundwater. However, further excavation was not completed because pre-RA characterization activities indicated that the lateral and vertical extent of COCs was greater than the ROD's soil excavation limit of 10 feet bgs (Navy, 2009) and would require extensive shoring in Building 251 to complete. The Navy is evaluating a revised approach to achieve soil RAOs and address a potential ongoing source to A-aquifer groundwater (ECC-Insight, 2019). The investigation expected to occur by Spring 2027.
- **RU-C4:** The Navy has initiated a study to evaluate the F-WBZ in the vicinity of elevated TCE reported during Basewide groundwater monitoring. The investigation is expected to be completed by Fall 2026.

Durable Cover Installation

The construction of durable covers began in June 2015 and was completed in May 2016.

Completion of the durable covers along with implementation of ICs, discussed in

Section 1.3.4.2, meets the RAOs for soil applicable to Parcel C. Response complete for soil is documented in the RACR for durable covers remedy in Parcel C (TtEC, 2017c). Durable covers consist of shoreline armoring; soil cover installation; asphalt cover installation, replacement, or repairs; and building foundation repairs, as shown on **Figure 4-2** and described as follows:

- **Shoreline Armoring:** Shoreline armoring was constructed along approximately 80 linear feet of deteriorated seawall northeast of Building 231. Shoreline armoring included, from the bottom up, filter fabric to prevent migration of soil to San Francisco Bay, a 6-inch minimum layer of filter rock, and a 3-foot minimum layer of riprap to protect the fabric from wave action.
- **Soil Cover:** A 2-foot-thick soil cover made up of clean imported soil was constructed on the hillside in the northwestern corner of Parcel C (RU-C5). The soil cover includes surface completions for monitoring wells.
- **Asphalt Cover:** The asphalt cover was constructed over the remaining areas of Parcel C. Most of Parcel C was covered with degraded asphalt pavement before the RA, and the existing asphalt pavement was repaired or replaced as needed to create a continuous intact cover. Repaired areas were typically overlain with new asphaltic concrete to achieve a 2-inch-thick cover. Asphalt replacement consisted of 4 inches of aggregate base course overlain by 2 inches of asphaltic concrete. Drainage features, such as swales, catch basins, and storm drain pipes, were incorporated into the asphalt cover to convey stormwater offsite (TtEC, 2017c).
- **Building Foundation Repairs:** Building foundation repairs were completed by using a variety of materials such as concrete, non-shrink grout, and asphaltic concrete, to prevent access to underlying soil. Building foundations that could not be restored or repaired (for example, historical buildings) were secured using a combination of steel plates, framed plywood walls, wire mesh, or chain-link fence to prevent access. Access to soil under buildings through crawlspaces and vaults was blocked with durable wire mesh or secured with steel ties.

Soil Vapor Extraction and Monitoring

Construction and operation of five SVE systems to remediate 8 soil vapor areas within RU-C1, RU-C4, and RU-C5 began in 2013 (**Figure 4-3**; APTIM, 2018). Each system includes a blower, blower motor, main control panel, SVE wells, vapor monitoring wells, liquid/air separator, transfer pump and liquid storage tank, conveyance piping and connection hoses, granular activated carbon vessels, level switches, system interlocks and controls, and gauges. The following is a summary of each system's operation timeframe and cumulative VOC removal:

- Area 1 (RU-C4): Constructed and operated for 4 months in 2001; operated August 2014 to February 2016, May 2016 to June 2017. Estimated cumulative removal was 3.9 pounds (predominantly TCE).
- Area 2 (RU-C2): Constructed but not yet operated.
- Areas 3/4/5 (RU-C5): Constructed and operated for 5 months in 2001; operated August 2014 to December 2015. Areas 4 and 5 SVE system constructed in February 2016. SVE Areas 3/4/5 operated May 2016 to November 2016. Estimated cumulative removal was 1.95 pounds (predominantly tetrachloroethene [PCE] and TCE).
- Areas 6/7 (RU-C1): Constructed and operated for 3 months in 2001; operated August 2014 to July 2014, September to December 2015, and May 2016 to September 2016. Estimated cumulative removal was 4.33 pounds (predominantly TCE).
- Area 8 (RU-C1): Constructed and operated for 4 months in 2001; operated August 2014 to February 2016, and July to September 2016. Estimated cumulative removal was 23.21 pounds (predominantly PCE and TCE).

The evaluation of the VOC mass removed as a result of the SVE O&M in SVE Areas 1, 3/4/5, and 6/7 indicate that the SVE operation in Parcel C has reached points of diminishing return and, in general, has had limited effectiveness in treating mass in soil due to the following primary reasons:

- The shallow groundwater table (mostly less than 7 feet bgs in all areas and 2 feet bgs in SVE Area 3) limits the effectiveness of the SVE system.
- Low SVE rates limited by low-permeability soil or sediment and water entrainment in the SVE wells.
- RAs (groundwater treatment) in the vicinity of SVE areas are not yet complete and likely contributing to the apparent ineffectiveness of SVE in reducing vapor concentrations to less than SGALs.

The Navy is in the process of reviewing the strategy for addressing soil gas at all Parcel C areas in conjunction with additional in situ groundwater remediation activities that are ongoing (ECC-Insight and CDM Smith, 2019). The work plan for post-remediation soil gas surveys at Parcel C is anticipated for spring 2029 and fieldwork is anticipated to begin between 2029 and 2030.

In Situ Groundwater Remediation

In situ groundwater remediation consists of treating COCs (VOCs or chromium VI) in A-aquifer groundwater using ZVI or an injected biological substrate in the groundwater plumes at RU-C1, RU-C2, RU-C4, and RU-C5. Target treatment area and subsequent performance metrics were selected based on active treatment criteria (ATCs) developed in the FS (SulTech, 2008), ROD (Navy, 2010), and RD (KCH, 2012). The groundwater ATCs and activities are as follows:

- ZVI treatment to target hotspot areas where concentrations of PCE exceed 15 µg/L or concentrations of TCE exceed 110 µg/L.
- Anaerobic in situ bioremediation (ISB) treatment targeted areas where VOCs exceed the RG by factors ranging from 10 to 50 and where chromium VI exceeds RGs. Zinc was initially targeted for active treatment but was documented not to be warranted based on pre-remedial characterization sampling (APTIM, 2018).
- Aerobic ISB treatment will target areas where 1,4-dichlorobenzene is greater than 21 µg/L or chlorobenzene is greater than 3,900 µg/L.

Between 2013 and 2017, groundwater remediation was conducted in chlorinated ethene and chromium VI plumes within RU-C1, C4, and C5 (APTIM, 2018). Chlorinated ethene plumes were treated in situ by direct injection of ZVI or an anaerobic organic substrate (sodium lactate) with bioaugmentation (*Dehalococcoides*, specifically SDC-9). The chromium VI plumes were treated using anaerobic ISB by injecting food-grade molasses as a substrate. Aerobic treatment was completed by direct injection of an oxygen-releasing compound (PermeOx Ultra). The following is a summary of the approximate injection totals:

- 206,183 pounds of ZVI was injected into 40 injection points.
- 123,503 gallons of diluted sodium lactate with SDC-9 culture was injected into 131 injection points.
- 16,064 gallons of food-grade molasses and water were injected into 17 injection points.
- 5,975 pounds of PermeOx Ultra was injected into eight injection points.

Monitoring results showed that the concentrations of COCs in source areas were significantly reduced by ZVI and anaerobic or aerobic ISB treatment activities in RU-C1, C4, and C5. Post-injection monitoring is currently being conducted under the BGMP. Chromium VI was successfully reduced by anaerobic bioremediation in target treatment areas within RU-C1 and RU-C5 with concentrations remaining less than treatment goals through the end of the performance monitoring period. Groundwater treatment minimized the potential for chromium VI to migrate to the bay at concentrations greater than the surface water quality criteria (APTIM, 2018).

In 2019, RU-C1 and RU-C2 were treated using a ZVI, Lactoil/WilclearPlus amendment mix; 249,120 pounds of ZVI and 1,130 gallons of Lactoil/WilclearPlus were injected. Bioaugmentation with KB-1 (SIREM) culture was completed in RU-C2 (ECC-Insight and CDM Smith, 2021). Performance monitoring is ongoing, and additional investigations and RAs are planned in RU-C1 (DNAPL source investigation), RU-C2, RU-C4, and RU-C5 (IGI, 2020; Gilbane, 2022). In September through December 2021, an RA was completed in RU-C4 to treat VOCs (IGI, 2020; TRBW, 2022b).

Groundwater Monitoring

Groundwater monitoring is conducted under the BGMP and includes LTM, remedy performance monitoring, and MNA, depending on the plume being monitored. Data evaluation and proposed changes to the Parcel C BGMP sampling locations, analytical requirements, and sampling frequency and approach have been presented in the Parcel C Remedial Action Monitoring Reports (RAMRs) for review and concurrence by BCT before incorporation into the BGMP (IGI, 2020). The Navy and the FFA regulatory parties are currently evaluating different approaches to present future changes to Parcel C BGMP sampling locations, analytical

requirements, and sampling frequency. Changes to which FFA regulatory parties have agreed in writing will be implemented per the agreement before incorporation into the BGMP.

Performance monitoring is generally conducted for a Parcel C groundwater plume at frequencies of 1, 3, 6, 9, and 12 months during the first year after in situ groundwater injections and semiannually during the second year to obtain a minimum of seven data points for evaluation. The following criteria are used to determine how a BGMP well is monitored and to define key decision points:

- If COC concentration trend analyses of specific BGMP COC plume wells evaluated as part of the Parcel C RAMR show stable, no trend, or declining COC concentration trends greater than ATCs, then performance monitoring at that BGMP plume well will continue.
- If COC concentration trend analyses of specific BGMP COC plume wells evaluated as part of the Parcel C RAMR show stable or declining COC concentration trends greater than RGs (but less than ATCs), then the MNA monitoring period will ensue until RGs are met.
- If statistical data demonstrate that concentrations are less than RGs following the minimum 2 years of performance monitoring and 1 year of MNA monitoring, closure of the plume will be initiated, with BCT review and concurrence.
- If COC concentration trend analyses of specific BGMP COC plume wells evaluated as part of the Parcel C RAMR show stable, no trend, or increasing COC concentration trends greater than ATCs, then performance monitoring at that BGMP plume well will continue and the Navy will consider further active treatment.

As a result, the number of monitoring wells sampled during each monitoring event can fluctuate based on data and recommendations from BCT. Annual and semiannual groundwater monitoring reports from 2019 through 2022 were also reviewed (TRBW, 2020b, 2020c, 2022a, 2022b, 2023b). **Appendix E** presents exceedances of the RGs (identified as PALs) and the ATCs from 2019, 2020, 2021, and 2022.

Figures 4-4 through 4-7 present groundwater concentrations from the 2021 annual monitoring. The following is a summary of the most recent (2022) groundwater monitoring results by RU and plume at Parcel C and the RAMR evaluating the 2021 data (IGI, 2023).

RU-C1 (Figure 4-4)

- Plume RU-C1-1 is currently undergoing performance monitoring for ISB and ZVI injections that were completed in May 2019 to treat VOCs. Benzene, PCE, TCE, and VC consistently exceeded RGs from 2019 to 2022, and benzene, VC, and PCE exceeded the ATCs during one or more rounds of sampling. Six A-aquifer monitoring wells were sampled in March and September 2022. Benzene, PCE, TCE, and VC exceeded RGs in March and benzene and PCE exceeded the RGs in September. PCE also exceeded ATC in March but not in September. Performance monitoring is expected to continue until data are statistically less than ATCs. Based on data up to December 2021 PCE data is statistically higher than the ATC; however, statistical trends indicate it is probably decreasing (IGI, 2023). Conditions are generally conducive to anaerobic degradation indicated by depleted dissolved oxygen (that is, less than 1 milligram per liter), presence of dissolved redox-sensitive metals (iron and manganese), and methane. The presence of ethene or ethane also indicates that complete biotic or abiotic degradation is occurring (IGI, 2023).

- Plume RU-C1-2 is currently undergoing MNA for VOCs (PCE and degradation products TCE, cis-1,2-dichloroethene [cis-1,2-DCE], and VC). PCE has sporadically exceeded the RG in one location throughout the monitoring period and benzene exceeded the RG during the January through June sampling periods of 2019 and 2020. Five A-aquifer monitoring wells were sampled in March 2022 with only benzene exceeding the RG. Five A-aquifer monitoring wells were sampled in September 2022, and there were no exceedances of RGs. There were no exceedances of ATCs during this monitoring period. MNA parameters indicate moderate to high potential for anaerobic attenuation of COCs. Statistical evaluation indicates that PCE (no trend) and benzene (stable trend) have UCLs that exceed the RG at one well each. MNA will continue until statistical data demonstrate that concentrations are less than RGs, at which time plume closure may be initiated with BCT review and concurrence (IGI, 2023).
- Plume RU-C1-3 is currently undergoing performance monitoring for ISB and ZVI injections that were completed in 2016 to treat VOCs. Additional characterization in 2017 to 2018 indicated the presence of DNAPL and light nonaqueous phase liquid (LNAPL) source under the paint room and sumps in Building 253, in the southern portion of RU-C1-3. Eight A-aquifer monitoring wells were sampled in both March and September 2022, and several VOCs (1,1,2,2-tetrachloroethane, 1,1-dichloroethane, 1,2,4-trimethylbenzene, 1,2-DCE, 1,3,5-trimethylbenzene, cis-1,2-DCE, benzene, isopropylbenzene, naphthalene, PCE, TCE, and VC) exceeded RGs at one or more locations during 2019, 2020, 2021 and 2022 events, and 1,2-DCE, benzene, and VC exceeded ATCs in 2022. Non-aqueous phase liquid (NAPL) has also been observed in IR28MW557A, and concentrations are greatest in samples collected from that location (**Appendix E** and **Figure 4-4**). Performance monitoring will continue and the Navy is planning to address the DNAPL source area and dissolved groundwater plume (IGI, 2023).
- RU-C1-4 was sampled in March and September 2022 (three A-aquifer monitoring wells just south of Dry Dock 2: IR28MW561A, IR28MW125A, and IR28MW562A) for chromium VI. Monitoring was discontinued in 2020 after the UCL of the mean for all COCs was less than RGs but was added back to the BGMP in September 2021 based on discussions between regulatory agencies and the Navy. Chromium VI was not detected in any monitoring wells and has not exceeded the RG of 50 µg/L since February 2014 (TRBW, 2023).

RU-C2 (Figure 4-5)

- Plume RU-C2-1 is currently undergoing performance monitoring for ISB completed in 2013 to treat VOCs. Eleven monitoring wells in both the A- and B-aquifer were sampled in 2022. In the A-aquifer, PCE, TCE, 1,4-dichlorobenzene, benzene, chlorobenzene, chloroform, and VC exceeded RGs at one or more samples during one or more sampling events during the review period. PCE, benzene, chloroform, and VC exceeded ATCs at one or more locations during one or more sampling events during this review period (2019-2022). Data indicate that degradation is occurring and conditions are favorable for continued degradation (IGI, 2023). Performance monitoring will continue because the criteria for MNA have not been met and additional RAs are planned for the RU-C2-1 plume (Gilbane, 2022). Adding sampling of a downgradient well, IR28MW398A, to the BGMP was recommended (IGI, 2023).

Monitoring in the B-aquifer was discontinued in September 2020 because there were no RAOs for the B-aquifer in the ROD because of the beneficial reuse exemption discussed in **Section 1.3.4.2** (Navy, 2010); however, after concerns were raised by the USEPA and Regional Water Board in July 2021 (USEPA and Regional Water Board, 2021), B-aquifer

monitoring was reinstated. PCE was the most widely detected chemical in the B-aquifer with concentrations ranging from 15 to 270 µg/L (less than 100 times the federal MCL of 5 µg/L) in 2022. TCE, vinyl chloride, and benzene were detected in B-aquifer samples at concentrations within 1 to 10 times their respective MCLs (IGI, 2023).

- Plume RU-C2-2 is currently undergoing MNA for VOCs. Monitoring wells in both the A- and B-aquifer are sampled. PCE, carbon tetrachloride, and chloroform have exceeded the RGs and ATCs at one or more location during this review period (2019 to 2022). PCE was the only VOC to exceed the RG in a single well during both sampling events in 2022 (RUC2MW11A). A review of MNA geochemical parameters indicated that conditions within the ISB treatment area are generally moderately conducive to anaerobic degradation. In 2021, the UCL of the mean of chloroform and carbon tetrachloride were below the RG with the exception of one location. However, PCE began exceeding the RG sporadically and was added to the statistical evaluation for the plume in 2021 (IGI, 2021) and exhibits an increasing trend using data through September 2021 (IGI, 2023). MNA will continue until criteria for plume closure have been met.
- Plume RU-C2-3 is currently undergoing performance monitoring for ISB and ZVI injections conducted in May 2019 for VOCs (primarily chloroform, TCE, and carbon tetrachloride). Monitoring wells in fractured bedrock and the A-aquifer are sampled and 1,4-dichlorobenzene, benzene, carbon tetrachloride, chloroform, TCE, and VC in groundwater exceeded RGs, and carbon tetrachloride, chloroform, and VC exceeded ATCs in one or more locations in March and September 2022. Conditions were considered generally favorable for anaerobic degradation (IGI, 2023). Statistical evaluation of the data indicates that multiple carbon tetrachloride, benzene, and 1,4-dichlorobenzene are increasing in one or more locations. Notably, carbon tetrachloride (increasing trend) and chloroform (stable trend) UCL data from downgradient well IR28MW940F continues to exceed ATCs. The Navy intends to prepare a RAWP to implement additional phases of remediation to address persistent chlorinated methane concentrations above ATCs in the vicinity of IR28MW940F. Performance monitoring will continue until conditions for MNA have been met.

RU-C4 (Figure 4-6)

- Plume RU-C4-1 is the only groundwater plume in RU-C4 and is currently undergoing performance monitoring for ISB and ZVI injections completed in September through December 2021 to treat VOCs (primarily PCE and degradation products). Groundwater samples were collected from 6 monitoring wells in March 2022, 19 monitoring wells in September 2022, and 12 monitoring wells in December 2022. All monitoring wells were in the A-aquifer except IR28MW272F, which is in the F-WBZ. In 2022, 1,2-dichloroethane, 1,4-dichlorobenzene, benzene, chloroform, cis-1,2-DCE, TCE, and VC exceeded the RGs in one or more locations. TCE and VC exceeded ATCs in 2019, 2020, and 2022, but there were no exceedances of ATCs in 2021; however, the BGMP did not include wells within the RA treatment area in 2021 Performance monitoring is underway.

RU-C5 (Figure 4-7)

- Plume RU-C5-1 is currently undergoing performance monitoring for ISB and ZVI injections completed in 2014 and 2016 to treat VOCs. Seven A-aquifer monitoring wells are sampled for VOCs and MNA parameters. Several VOCs (1,1-dichloroethane, 1,2-DCE, benzene, cis-1,2-DCE, PCE, TCE, and VC) exceeded their RGs, and PCE, TCE, and VC exceeded their ATCs in one or more location and events during this review period. Samples collected

at IR06MW67A consistently exhibit the highest concentrations and statistical evaluation indicates COC concentrations are stable, no trend, or increasing/probably increasing. Conditions are favorable for MNA and presence of increasing concentrations of degradation products indicate that biodegradation is occurring (IGI, 2023). Performance monitoring will continue, and additional RA is planned to address persistent COCs greater than ATCs in the IR06MW67A area (Gilbane, 2022; IGI, 2023).

- Plume RU-C5-2 was sampled in September 2021 for chromium VI. Like plume RU-C1-4, sampling at RU-C5-2 was discontinued because conditions for plume closure were met; however, sampling three fractured bedrock monitoring wells (IR06MW68F, IR06MW69F, and IR06MW70FR) was added back into the BGMP based on discussions between the agencies and the Navy. Chromium VI was reported at a concentration of 40.2 µg/L, less than the TL of 50 µg/L, in September 2021 and was not detected in March or September 2022. Chromium VI has historically been detected in RU-C5-2 at concentrations less than the TL since the wells were incorporated into the BGMP in 2015 (TRBW, 2023).
- Plume RU-C5-3 is currently undergoing performance monitoring for aerobic ISB injections completed in February 2016 to address VOCs (primarily naphthalene). Samples are collected from three A-aquifer monitoring wells and analyzed for VOCs, chromium VI, and MNA parameters. Naphthalene has consistently exceeded the RG in one location (IR06MW42A) during all sampling events during this review period. Chromium VI was not detected in groundwater during any events during this review period. There were no exceedances of ATCs during this review period, but statistical evaluation in the 2021 RAMR indicated the UCL of naphthalene exceeded the ATC. Conditions have transitioned from being favorable for aerobic degradation in 2019 to anaerobic in 2020 (unfavorable for naphthalene degradation), and naphthalene is stable based on statistical evaluation (IGI, 2023). Performance monitoring will continue, and an additional RA is planned to address persistent naphthalene greater than the ATC (Gilbane, 2022).
- Plume RU-C5-4 is currently undergoing performance monitoring for ISB and ZVI injections completed in January to February 2016 to address VOCs. Four A-aquifer monitoring wells are sampled for VOCs and MNA parameters. Benzene and VC exceeded their RGs but not ATCs during this review period. MNA parameters indicate conditions are favorable for anaerobic bioremediation (IGI, 2023). Statistical evaluation completed on 2021 and earlier data indicated that the UCL for VC continued to exceed the ATC, so performance monitoring continued through 2021. Continued performance monitoring was recommended in the Fall 2021 RAMR (IGI, 2023).
- Plume RU-C5-5 is currently undergoing performance monitoring for aerobic ISB completed in February 2016 and an additional RA in 2021 to address VOCs (primarily chlorinated benzenes). In 2022, three monitoring wells were sampled in March, five different monitoring wells were sampled in June, and all eight were sampled in September. Eight VOCs (1,2-dichloroethane, 1,4-dichlorobenzene, benzene, chlorobenzene, naphthalene, PCE, TCE, and VC) exceeded their respective RGs, and 1,4-dichlorobenzene, benzene, and chlorobenzene exceeded their ATCs in 2022. Performance monitoring for the 2021 RA is currently underway. Visual trends for source area monitoring well concentrations generally indicate that while some COCs initially decreased in concentration immediately after the 2021 RA, most have rebounded, and some have increased above concentrations before the RA. The need for additional RAs will be evaluated based on the decision criteria established in the RAMP.

Radiological Surveys and Remediation

ROCs suspected to be present at Parcel C include potassium-40 (K-40), Co-60, Sr-90, Cs-137, Ra-226, thorium-232 (Th-232), and Pu-239. The following buildings at Parcel C were designated as radiologically impacted: Buildings 203, 205 and discharge tunnel, 211, 214, 224, 241, 253, 271, and 272. The Navy conducted a TCRA at Parcel C to address potential radioactive contamination in storm drains and sanitary sewer lines and radiologically impacted structures (TtEC, 2016, 2017b). In total, 67,596 cubic yards of soil was excavated during removal of 31,190 linear feet of sanitary sewer and storm drain lines. Approximately 6,641 cubic yards of soil was disposed of offsite as LLRW based on surface scan and analytical laboratory results. Additional characterization surveys of the sanitary sewer lines and storm drains within the Parcel C Historic District were also performed (APTIM, 2020). Additionally, FSSs were performed at six radiologically impacted buildings (Buildings 203, 214, 224, 241, 271, and 272) and radiologically impacted sites (North Pier and Ship Berths 1 to 5) (TtEC, 2016, 2017a, 2017b). Additional surveys are planned at three radiologically impacted buildings (Buildings 211, 253, and the discharge channel at Building 205) (TtEC, 2017b).

The TCRA data were reviewed as described in **Section 1.4.3**, and radiological retesting, including sampling and surveys of soils previously investigated during sanitary sewer line storm drain removal and resurvey of impacted buildings and former building sites, is currently being conducted to determine if current site conditions are compliant with the RAOs.

Institutional Controls

The entire area of Parcel C (73 acres) is subject to soil, soil gas, and groundwater ICs. IC performance objectives were developed and presented in the ROD (Navy, 2010) and LUC RD (Appendix B of KCH, 2012). **Table 1-3** summarizes the IC performance objectives to be implemented through land use restrictions for the site.

4.4.1.2 *Remedy Operations and Maintenance*

Ongoing O&M at Parcel C includes maintaining the integrity of the durable covers and IC inspections. The inspection and maintenance requirements for the durable covers are described in the Final O&M Plan for Parcel C (Navy, 2017). AOMSRs are prepared to summarize inspections and maintenance performed and to document the effectiveness of the remedy components. AOMSRs from 2019, 2020, 2021, and 2022 were reviewed (Innovex-ERRG Joint Venture, 2020, 2021; APTIM, 2022, 2023).

Durable Cover Maintenance

The shoreline armoring was determined to be in good condition. No signs of vegetation or trash, pests, excessive vehicle traffic, settlement or movement, wave overtopping, or scouring were found.

Annual inspections found the soil cover to be in good condition, with no signs of settling, slope failure, cracking, soil movement, erosion, or burrowing pests. Vegetation growth was well established over the soil cover, with no bare areas observed.

The asphalt cover was generally in good condition with the exception of the eastern portion of Parcel C where subsidence areas greater than 4 feet deep were found at several locations. Two areas of previous repair were heavily deteriorated and formed major subsidence areas (7 feet wide by 25 feet long by 6 feet deep and 6 feet wide by 20 feet long by 7 feet deep). A 7-foot-deep void observed along the pier edge that allowed water to wash in and out with the tide may have contributed to the subsidence. The subsidence areas were repaired. Subsidence was

noted near Buildings 205, 207, and 208 between Dry Dock 2 and Dry Dock 3 that required extensive repairs outside of routine O&M, and 100 feet of permanent chain-link fence was installed across Building 208 to secure the end of the pier. Minor subsidence areas (less than 4 feet deep) were observed during the 2022 inspection; however, repairs were not recommended until the completion of radiological retesting in the area to minimize generating waste and rework. The Navy is currently conducting a shoreline assessment study to identify and recommend repairs and/or stabilization of structures and shoreline.

Building foundations were generally in good condition, and any cracks or potholes were repaired during routine O&M activities.

Institutional Control Compliance

ICs are inspected annually, and no deficiencies or inconsistent uses were observed during the review. General site conditions were determined to be good. Remedy components, such as survey benchmarks and monitoring well vault covers, were found to be in good conditions.

The Navy controls access to the parcel using security fencing, signage, locks, and gates, which were found to be in good condition. However, during the September 2021 inspection, the metal hasp on a door that secures Building 367 was found broken during the annual inspection. The door was re-secured on Building 367 to prevent unauthorized access (APTIM, 2022).

4.4.2 Parcel UC-2

The RA for Parcel UC-2 includes the following major components:

- Durable cover installation and maintenance to address COCs in soil
- Radiological surveys and remediation through soil excavation and removal of sanitary sewer and storm drain lines
- LTM of groundwater for COCs
- ICs for VOCs

Figures 4-1, 4-2, and 4-7 show remedy components.

4.4.2.1 Remedy Implementation

Durable Cover Installation

Durable covers were constructed between May 14, 2012, and September 18, 2012. Completion of the durable covers along with ICs, as discussed in **Section 1.3.4.2**, meets the RAOs for soil in Parcel UC-2. Response complete is documented in the RACR for Parcels UC-1 and UC-2 (ERRG, 2013). The RA includes installation and repair of durable covers, including soil covers, asphalt covers, and building foundations, to minimize exposure of humans and wildlife to potential COCs in underlying soil, as shown on **Figure 4-8** and described as follows:

- **Soil Cover:** A 2-foot-thick soil cover made up of clean imported fill was installed over previously vegetated areas by removing 2 feet of existing soil so that the surface of the newly installed cover matched historical site grades. Live beach strawberry, California poppy, and summer lupine plants were then hand-planted across the entire soil cover to provide future slope stability and aesthetic appeal.
- **Asphalt Covers:** An 8-inch asphalt cover, with a minimum of 4 inches of asphalt concrete and 4 inches of aggregate base, was installed. Existing AC covers that were in good condition were left in place and incorporated into the final AC cover. Degraded existing AC

covers were repaired by removing and replacing one or more of the following: AC cover, aggregate base, or subbase material, depending on the level of degradation. AC covers with minor cracking were repaired by applying an asphalt seal to fill the cracks.

- **Restored Building Foundations:** Concrete building foundations and sidewalks were restored and incorporated into the durable cover, and cracks and penetrations were filled with non-shrink grout.

Radiological Surveys and Remediation

The ROPCs at Parcels UC-2 include Cs-137, Ra-226, and Sr-90, and are associated with sanitary sewer lines and storm drain lines (Navy, 2009). The Navy conducted TCRAs at Parcel UC-2 to address potential radioactive contamination in storm drains and sanitary sewer lines at Parcels UC-1 (adjacent to Parcel UC-2) and UC-2 (ChaduxTt, 2010a; TtEC, 2011). In total, approximately 20,680 cubic yards of soil was excavated during removal of approximately 6,407 linear feet of sanitary sewer and storm drain lines. Approximately 1,138 cubic yards of soil was disposed of offsite as LLRW based on surface scan and analytical laboratory results. TCRAs for radionuclides were completed, and the radiological RGs established in the ROD for Parcel UC-2 were presumed to be met (Navy, 2009).

The TCRA data were reviewed, as described in **Section 1.4.3**, and radiological retesting, including sampling and surveys of soils previously investigated during sanitary sewer line storm drain removal and resurvey of impacted buildings and former building sites, is currently being conducted to determine if current site conditions are compliant with the RAOs.

Groundwater LTM

Groundwater monitoring at Parcel UC-2 is conducted under the BGMP. Annual and semiannual groundwater monitoring reports from 2019 through 2022 were reviewed (TRBW, 2020b, 2020c, 2021, 2022a, 2022b, 2023). **Appendix E** presents exceedances of RGs (identified as PALs) from 2019, 2020, 2021, and 2022.

Two groundwater monitoring wells are sampled semiannually for VOCs. Carbon tetrachloride and chloroform consistently exceed the RGs; however, during 2022, carbon tetrachloride was the only COC that exceeded the RG. Concentrations of carbon tetrachloride are generally within 1 order of magnitude of the RG (0.5 µg/L), and concentrations of chloroform are generally the same order of magnitude as the RG (1 µg/L). No RA for groundwater treatment is required at this time. Ownership of Parcel UC-2 has been transferred to the City of San Francisco and is no longer Navy property; however, sampling of the monitoring wells is still included in the BGMP.

Institutional Controls

The entire area of Parcel UC-2 (3.9 acres) is subject to soil and groundwater ICs. IC performance objectives were developed and presented in the ROD (Navy, 2009) and LUC RD (ChaduxTt, 2010b). A portion of Parcel UC-2 located adjacent to Parcel UC-1, is also subjected to ARICs for VOCs. **Table 1-3** summarizes the IC performance objectives to be implemented through land use restrictions for the site. The ICs are currently being enforced through a Covenant to Restrict Use of Property recorded on September 16, 2015 (Navy, 2015).

4.4.2.2 *Remedy Operations and Maintenance*

Ongoing O&M at Parcel UC-2 is the responsibility of the City and County of San Francisco OCII's contractor in accordance with the approved Risk Management Plan (Geosyntec, 2019) and O&M Plan (Navy, 2013). Annual reports from the City and County of San Francisco's OCII

contractor summarizing durable cover O&M and IC inspections were reviewed (Geosyntec-Albion Joint Association, 2020, 2021, 2022).

Durable Cover Maintenance

Minor settling was observed during the 2021 inspection, and evidence of burrowing pests within the soil cover were observed during the 2020 and 2021 inspections. Repairs were conducted in October 2020, December 2021, and January 2022. Vegetation in the soil cover is in good condition.

In general, the durable cover was found in good condition with minor crack and pothole repairs completed during O&M. An area in Parcel UC-2, the Hunters Point Artists Parcel, was scheduled for redevelopment, resulting in removal of the durable cover in the area in October 2017. Construction was put on hold indefinitely in June 2018, leaving a portion of the durable cover missing. The area is secured with a chain-link fence surrounding the uncovered area and is treated with tackifier annually for dust control. A Notice of Termination for the Hunters Point Artists Parcel project was submitted to the State Water Boards Stormwater Multiple Applications and Report Tracking System in August 2020.

Institutional Controls Compliance

No deficiencies or inconsistent uses were observed during the review period.

4.4.3 Progress Since the Fourth Five-Year Review

Table 4-5 summarizes issues, recommendations, and follow-up actions from the Fourth Five-Year Review.

4.5 Technical Assessment

4.5.1 Question A: Is the Remedy Functioning as Intended by the Decision Document?

4.5.1.1 Parcel C

Yes. Based on the review of historical documents, annual O&M inspections, and the Five-Year Review inspection, the remedy at Parcel C is functioning as intended.

Soil hotspot areas were removed through excavation and offsite disposal and additional hot spot removal is planned to address deeper than anticipated chemicals at Building 251. Exposure pathways that could result in an unacceptable risk are being controlled through durable covers and ICs. The shoreline revetment, soil cover, and asphalt cover are in good condition, and any minor issues have been repaired. Areas needing repair outside of typical O&M are secured to prevent access. Although the SVE soil remedy did not function as well as intended, the SVE technology was intended to remove source-level concentrations and meet RAOs through other remedy components. Short-term protectiveness is achieved because ICs are in place to ensure current and future exposures through the vapor intrusion pathway do not occur. Groundwater remediation and MNA/LTM are ongoing, and ICs prevent exposure to groundwater while treatment is ongoing. Radiological concerns are addressed through previous radiological surveys and remediation of soil and building structures, and radiological retesting is being conducted to confirm that the RAO has been met, with the goal of unrestricted closure. Radiological retesting is underway.

4.5.1.2 Parcel UC-2

Yes. Based on the review of historical documents, annual O&M inspections, and the Five-Year Review inspection, the remedy at Parcel UC-2 is functioning as intended.

Exposure pathways that could result in an unacceptable risk are being controlled through durable covers and ICs. Groundwater monitoring is ongoing, and ICs prevent exposure to groundwater until that time. The soil and asphalt covers are in good condition, and any minor issues have been repaired. Radiological concerns are addressed through previous radiological surveys and remediation of soil and building structures, and radiological retesting is being conducted to confirm that the RAO has been met, with the goal of unrestricted closure. Radiological retesting is planned for 2023.

4.5.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Selection Still Valid?

Uncertain. Based on the results of the ARAR evaluation, HHRA analysis, and ERA analysis discussed in the following sections, the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid for soil and A-aquifer groundwater. Although there have been some changes to toxicity values and risk assessment methods, these changes do not affect remedy protectiveness for soil and A-aquifer groundwater. However, chemicals were identified in the B-aquifer and F-WBZ groundwater that require additional investigation to determine if the exposure assumptions, toxicity data, cleanup levels, and RAOs at the time of remedy selection remain valid for these groundwater zones.

4.5.2.1 ARAR Evaluation

The Navy evaluated the ARARs established in the RODs and ESD for Parcel C and Parcel UC-2. No changes to location-specific or action-specific ARARs that would affect the protectiveness of the remedies were identified. Changes to chemical-specific ARARs for individual chemicals are discussed in the following HHRA and ERA Analysis sections.

In 2021, California Public Resources Code Division 20.6.5, California Sea Level Rise Mitigation and Adaptation Act of 2021, was passed; however, no regulations have been promulgated to implement the act. The Navy is addressing SLR, as discussed in **Section 1.4.2**, of this Five-Year Review.

4.5.2.2 HHRA Analysis

As **Section 3.5.2.1** notes, in 2018, the State of California promulgated the TCR. However, the Navy continues to view the values identified in the USEPA IRIS database (a Tier 1 value) as the primary source of toxicity factors for risk-related calculations. The HHRA evaluation was conducted by comparing the human health RGs from the ROD with current risk-based criteria based on the same exposure scenario and ARARs, if available. Response complete for soil was achieved with excavation, durable cover construction and maintenance, and ICs as documented in the respective RACRs for Parcels C and UC-2 (TtEC, 2017c; ERRG, 2013). Therefore, any changes in exposure assumptions and toxicity data would not affect protectiveness of the remedy.

Table 4-6 shows the RGs and current comparison criteria for groundwater. The RGs for the groundwater COCs included in the ROD were based on consideration of exposure scenario-specific (residential or industrial vapor intrusion and construction worker trench exposure [A-

aquifer], or residential domestic use [B-aquifer in RU-C5 only]), risk-based concentrations (based on a cancer risk of 10^{-6} or a noncancer hazard index of 1); laboratory PQLs; chemical-specific ARARs; and HGALs. RGs were compared with the following current comparison criteria (USEPA, 2022a):

- A-aquifer Groundwater: VISLs calculated using the current USEPA VISL calculator for the residential and commercial scenarios.
- B-aquifer Groundwater: Current USEPA tapwater RSLs, California MCLs, and USEPA MCLs.

For groundwater, there are a few cases where a current risk-based concentration (VISL or RSL) is less than a risk-based RG (or the PQL or HGALs) from the ROD (**Table 4-6**). Although current risk-based levels for some chemicals are lower than the RGs, the ICs that are currently in place and the durable cover across the site prevent exposure to site media; therefore, the remedy remains protective. There may be changes with HHRA analysis for the construction worker scenario. Changes in exposure parameter values would likely only result in a small change to HHRA results since standard construction worker exposure factors have not changed significantly since the RI was prepared (not orders of magnitude). The following construction worker exposure parameter values have changed since the original HHRA was prepared:

- The construction worker body weight used in the HHRA was 70 kilograms; however, the adult body weight used in HHRA based on current USEPA guidance (USEPA, 2014) would be 80 kilograms.
- The skin surface area for a construction worker exposed to soil used in the HHRA was 5,700 cm²; however, based on current USEPA guidance (USEPA, 2014), a construction worker skin surface area exposed to soil is 3,527 cm².
- The soil-to-skin adherence factor used in the HHRA for a construction worker was 0.8 milligram per cm², where the soil-to-skin adherence factor for a construction worker used in a current HHRA would be 0.3 milligram per cm² (the 95th percentile adherence factor for construction workers [USEPA, 2004]).
- The skin surface area for exposure to groundwater used in the HHRA was 2,370 cm². A current HHRA would use a skin surface area of 6,032 cm² (the weighted average of mean values for head, hands, forearms, and lower legs [USEPA, 2011]).
- Additionally, for inhalation exposures for both groundwater and soil, inhalation toxicity values are now presented and used in milligram(s) per cubic meter (noncancer) or 1 microgram per cubic meter for cancer; therefore, the intake equations no longer incorporate inhalation rate.

Toxicity values could result in larger changes (potential orders of magnitude changes), such as for TCE, for which toxicity values were updated in 2009 after the initial HHRA was completed. However, those changes will not affect the RGs for the construction worker scenario identified in the ROD because ICs require identification and management of potential risks to construction workers through the preparation and approval of plans and specifications for all construction activities that may pose unacceptable exposure to construction workers. There have been no changes in current exposure pathways based on the site controls, or changes in planned future site use since the ROD that would change the protectiveness of the current remedy.

Radiological Risk Review

In October 2020, after the preparation of the Five-Year Review addenda, USEPA introduced a PRG calculation method called “Peak PRG,” which computes PRGs accounting for ingrowth and decay of progeny over time. An evaluation was performed for this Five-Year Review to assess whether this change affected the continued protectiveness of the current soil RGs for future residents. Exposure calculations were performed using the USEPA PRG Calculator (USEPA, 2022b). For this soil evaluation, the estimated excess cancer risk was calculated using the “Peak Risk” time interval of 1,000 years (Navy, 2020). The soil RGs were used as exposure point concentrations, and the cumulative cancer risk was calculated as the sum of risks from all ROCs. **Appendix F** presents the calculated estimated excess cancer risks from this evaluation and the supporting data. Under CERCLA, cleanup goals are considered protective if excess cancer risks from site exposures remain within the 10^{-4} to 10^{-6} range. Based on the findings of this evaluation, the soil RGs are within this range and continue to be protective for future residential exposures.

There were no changes to the risk assessment methods related to structures or buildings for radiological concerns since the last Five-Year Review.

4.5.2.3 ERA Analysis

Table 4-7 presents groundwater COCs with a summary of TLs and current surface water quality criteria. Groundwater data were compared with surface water screening levels to evaluate potential for risk to aquatic organisms in San Francisco Bay. The evaluation of groundwater was very conservative because it was assumed that aquatic receptors would have direct exposure to chemicals in groundwater at their measured concentrations.

Chromium VI and zinc were retained for ongoing monitoring. Concentrations of chromium VI were successfully reduced by anaerobic bioremediation in target treatment areas within RU-C1 and RU-C5, with concentrations remaining less than treatment goals through the end of the performance monitoring period. Groundwater treatment minimized the potential for chromium VI to migrate to the bay at concentrations greater than the surface water quality criteria. The chronic marine NRWQC (USEPA, 2023) for each metal was set as the TL. These values have not changed since the FS and ROD were completed. The TLs remain current and protective of surface water exposures for aquatic organisms. Surface water TLs are for monitoring purposes only because surface water benchmarks are not ARARs for ecological exposures to groundwater.

4.5.3 Question C: Has Any Other Information Come to Light that Could Question the Protectiveness of the Remedy?

Yes. The following information has come to light that could question the protectiveness of the remedy:

- There have been detections of COCs from A-aquifer groundwater within the B-aquifer and F-WBZ groundwater and the connection and communication between hydrogeologic units within Parcel C is not fully understood. Therefore, further characterization of the Deep F-WBZ in RU-C4 and the B-aquifer and Upper F-WBZ in RU-C2 are required to demonstrate that remedies within the A-aquifer will be effective and not re-contaminated by COCs within the B-aquifer and F-WBZ and unacceptable discharges to the Bay are not and will not occur.
- As identified in the Fourth Five-Year Review, there is uncertainty with a portion of the radiological survey and remediation work. The Navy is in the process of implementing

corrective actions to ensure the radiological remedies specified in the decision documents were implemented as intended; however, this work is ongoing. Radiological retesting is currently being conducted at Parcels C and UC-2; long-term protectiveness will be confirmed upon completion.

4.6 Issues, Recommendations, and Follow-up Actions

Table 4-8 summarizes the issues, recommendations, and follow-up actions identified for Parcels C and UC-2.

4.6.1 Other Findings

The following findings were identified that do not directly relate to achieving or maintaining remedy protectiveness but are relevant to overall site management.

4.6.1.1 PFAS

As discussed in **Section 1.4.1**, a Basewide PA was conducted to identify potential PFAS release areas based on historical use or limited sampling data. The following is a summary of the areas identified for additional investigation in the PA (Multi-MAC JV, 2022) and SI (Liberty JV, 2023):

- **Parcel C A-aquifer Groundwater:** A-aquifer groundwater beneath Parcel C was identified for additional investigation because of past industrial use in the parcels and PFOA, PFOS, PFNA, and PFHxS exceeded project screening levels during the SI (**Appendix G**).
- **Parcel C:** Building 215, Fire Station, was identified as an area where further investigation is warranted in the form based on historical activities. During the SI, PFOA and PFOS exceeded project screening levels in soil and PFOA, PFOS, PFNA, and PFHxS exceeded project screening levels in groundwater (**Appendix G**).

There are no PFAS areas identified for additional investigation in Parcel UC-2. Exposure to groundwater and soil is restricted by ICs within the HPNS and the City and County of San Francisco prohibits installation of domestic wells within city and county limits.

4.6.1.2 Climate Resilience

The CRA estimates that groundwater emergence due to SLR may occur within Parcel C by the year 2065 (**Appendix A**). Site-specific studies are planned to verify these mapping projections and evaluate the 2100 timeframe, at a minimum.

However, protectiveness is only affected when increased CERCLA risk attributable to climate hazards has been identified (groundwater is likely to emerge and land use is such that receptors could be exposed and a future unacceptable health or ecological risk has been identified, data collected, validated, and evaluated following CERCLA risk assessment processes resulting in unacceptable risk to receptors). Where the potential for increased vapor intrusion is identified in other CERCLA documents, ARICs for VOCs are present, groundwater is being monitored, and removal of VOCs is occurring either through MNA or active remediation, thus reducing the potential for future vapor intrusion by reducing the source. Therefore, the potential for groundwater emergence does not affect the protectiveness determination in this Five-Year Review.

No SLR effects are anticipated for Parcel UC-2 by the year 2065.

4.6.1.3 Site Management Strategy

The Navy is reassessing the site management strategy for Parcels C and UC-2 based on the following considerations:

- The Navy is planning to conduct a detailed assessment of groundwater COC concentrations to document and eliminate COCs that have achieved response complete and to tabulate groundwater and soil COC concentrations to ensure health and safety professionals have the information needed to protect future construction workers.
- The Navy is also planning to optimize the monitoring frequency and locations for areas that have not undergone any changes that could affect the concentrations of chemicals or metals in groundwater (for example, RA or development construction).

4.7 Statement of Protectiveness

4.7.1 Parcel C

Protectiveness Determination: Protectiveness Deferred

Protectiveness Statement: A protectiveness determination cannot be made because there is uncertainty related to the hydrogeologic communication between the A- and B-aquifers and whether discharge of chemicals present in the B-aquifer present potential unacceptable risks to Bay receptors. In order to make a protectiveness determination, the following action, at a minimum, needs to be made: (1) complete investigations of the (a) Bay Mud/Sandy Lean Clay aquitard, (b) extent of chemicals in the deep F-WBZ in RU-C4, and (c) extent of chemicals in the B-aquifer and F-WBZ in RU-C2 and (2) use current ecological risk assessment methods and criteria, as appropriate, to assess potential impacts to Bay receptors.

The estimated timeframe for each action is as follows:

- Complete investigations of the Bay Mud/Sandy Lean Clay aquitard, expected to occur by Fall 2026
- Complete investigation of the extent of chemicals in the deep F-WBZ in RU-C4 expected to occur by Fall 2026
- Complete investigation of the extent of chemicals in the B-aquifer and F-WBZ in RU-C2 expected to occur by Spring 2027
- Assess potential impacts to Bay receptors, expected to occur by Fall 2026

The FFA parties will have discussions, as appropriate, prior to scoping and developing primary documents, such as workplans, expected to occur in Fall 2025. The protectiveness determination will be re-evaluated in the Five-Year Review addendum based on information that becomes available after the completion of this FYR.

The RAOs for soil are met through hotspot excavation and disposal, durable covers, and ICs. Groundwater remediation is ongoing, and, once active treatment is complete, MNA will continue until COCs reach RGs. Until that time, ICs control exposure to groundwater. Radiological retesting is ongoing to confirm that levels in soil and structures are protective of human health.

4.7.2 Parcel UC-2

Protectiveness Determination: Short-term Protective

Protectiveness Statement: The remedy at Parcel UC-2 is currently protective of human health and the environment. To determine whether the remedy can be considered protective in the long term, the radiological retesting work will be completed.

The RAOs for soil are met through durable covers and ICs. Groundwater monitoring is ongoing. Radiological retesting is ongoing to confirm that levels in soil and structures are protective of human health. Until retesting is complete, short-term protectiveness is met through Navy controls such as access to the parcel through fencing, locked gates, and ICs (restricting intrusive work and maintaining durable covers).

4.8 References

- Aptim Federal Services, LLC (APTIM). 2018. *Interim Remedial Action Completion Report, Parcel C Remedial Action, Remedial Units C1, C4, and C5, and Building 241 (Excludes C2), Hunters Point Naval Shipyard, San Francisco, California*. Final. March.
- APTIM. 2020. *Removal Action Completion Summary Report, Radiological Characterization Survey of Sanitary Sewers and Storm Drains, Parcel C Historic District, Hunters Point Naval Shipyard, CA*. June.
- APTIM. 2022. *2021 Annual Operation and Maintenance Summary Report, Parcels B-1, B-2, C, D-1, G, and UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. February 1.
- APTIM. 2023. *2022 Annual Operation and Maintenance Summary Report, Parcels B-1, B-2, C, D-1, G, and UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. February 1.
- CB&I Federal Services LLC (CB&I). 2013. *Work Plan, Parcel C Remedial Action, Remedial Units C1, C4, and C5, and Building 241 (Excludes C2), Hunters Point Naval Shipyard, San Francisco, California*. Final. July.
- ChaduxTt, A Joint Venture of St. George Chadux Corp. and Tetra Tech EM Inc. (ChaduxTt). 2010a. *Memorandum: Approach for Developing Soil Gas Action Levels for Vapor Intrusion Exposure at Hunters Point Shipyard, Hunters Point Shipyard, San Francisco, California*. April 30.
- ChaduxTt. 2010b. *Land Use Control Remedial Design Parcels UC-1 and UC-2, Hunters Point Shipyard, San Francisco, California*. December.
- CH2M Hill Kleinfelder Joint Venture (KCH). 2012. *Remedial Design and Design Basis Report for Parcel C, Hunters Point Naval Shipyard, San Francisco, California*. Final. October 5.
- Navy. 2009. *Hunters Point Shipyard, Parcel UC-2, Record of Decision*. Engineering Field Activity West, Naval Facilities Engineering Command. Final. December 17.
- Navy. 2010. *Record of Decision for Parcel C, Hunters Point Shipyard, San Francisco, California*. Final. September 30.
- Navy. 2013. *Hunters Point Shipyard, Operation and Maintenance Plan Parcels UC-1 and UC-2*. Engineering Field Activity West, Naval Facilities Engineering Command. Final. April 19.
- Navy. 2014. *Explanation of Significant Differences to the Final Record of Decision for Parcel C, Hunters Point Shipyard, San Francisco, California*. Final. October.

- Navy. 2015. *Covenant to Restrict Use of Property, Environmental Restrictions, Re: Hunters Point Naval Shipyard, Parcels UC-1 and UC-2, Department Site Code: 2000050, EPA I.D. No. CA1170090087*.
- Navy. 2017. *Operation and Maintenance Plan for the Durable Covers in Parcel C, Hunters Point Naval Shipyard, San Francisco, California*. Final. February.
- Navy. 2020. *Addendum to the Five-Year Review, Evaluation of Radiological Remedial Goals for Soil, Hunters Point Naval Shipyard, San Francisco, CA*. June 18.
- ECC-Insight, LLC. 2019. *Remedial Action Work Plan Addendum, Parcel C Remedial Units C1, C2, C4, and C5, Hunters Point Naval Shipyard, San Francisco, California*. April.
- ECC-Insight, LLC and CDM Smith. 2017. *Technical Memorandum, Optimized Remedial Alternative for Parcel F, Hunters Point Naval Shipyard, San Francisco, California*. Final. September.
- ECC-Insight, LLC and CDM Smith. 2019. *Parcel C Soil Vapor Extraction System Operation and Maintenance Summary Report, Hunters Point Naval Shipyard, San Francisco, California*. Final. February.
- ECC-Insight, LLC and CDM Smith. 2021. *Remedial Action Construction Summary Report, Parcel C, Remedial Units C1 and C2, Hunters Point Naval Shipyard, San Francisco, California*. Final. April.
- Engineering/Remediation Resources Group, Inc. (ERRG). 2013. *Remedial Action Completion Report for Parcels UC-1 and UC-2, Hunters Point Naval Shipyard, San Francisco, California*. Final. February.
- Geosyntec. 2019. *Risk Management Plan (RMP), Hunters Point Naval Shipyard, Parcels UC-1 and UC-2, San Francisco, California*. January.
- Geosyntec-Albion Joint Association. 2020. *2019 Annual Inspection and Reporting Forms, Parcels UC-1 and UC-2, Hunters Point Naval Shipyard, San Francisco, California*. April 7.
- Geosyntec-Albion Joint Association. 2021. *2020 Annual Inspection and Reporting Forms, Parcels UC-1 and UC-2, Hunters Point Naval Shipyard, San Francisco, California*. April 7.
- Geosyntec-Albion Joint Association. 2022. *2021 Annual Inspection and Reporting Forms, Parcels UC-1 and UC-2, Hunters Point Naval Shipyard, San Francisco, California*. April 7.
- Gilbane Federal (Gilbane). 2022. *Remedial Action Work Plan, Parcel C Phase III Remedial Action, Hunters Point Naval Shipyard, San Francisco, California*. Draft Final. October.
- Indus General Inc. (IGI). 2020. *Phase II Remedial Action Work Plan Parcel C, Remedial Units C2, C4, and C5, Hunters Point Naval Shipyard, San Francisco, California*. September.
- IGI. 2021. *Spring and Fall 2020 Combined Semiannual Remedial Action Monitoring Report for Parcel C, Remedial Units C1, C2, C4, and C5, Hunters Point Naval Shipyard, San Francisco, California*. Final. November.
- IGI. 2023. *Fall 2021 Semiannual Remedial Action Monitoring Report for Parcel C, Remedial Units C1, C2, C4, and C5, Hunters Point Naval Shipyard, San Francisco, California*. Final. June.
- Innovex-ERRG Joint Venture. 2020. *Annual Operation and Maintenance Summary Report for Parcels B-1, B-2, C, G, UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. January 8.

- Innovex-ERRG Joint Venture. 2021. *Annual Operation and Maintenance Summary Report for Parcels B-1, B-2, C, D-1, G, UC-3 and Installation Restoration Sites 07 and 18, Hunters Point Naval Shipyard, San Francisco, California*. Final. January.
- Liberty Joint Venture (Liberty JV). 2023. *Site Inspection for Basewide Investigation of Per- and Polyfluoroalkyl Substances, Former Hunters Point Naval Shipyard, San Francisco, California*. Final. September.
- Multi-MAC Joint Venture (Multi-MAC JV). 2022. *Preliminary Assessment Report Basewide Investigation of Per- and Polyfluoroalkyl Substances (PFAS), Former Hunters Point Naval Shipyard, San Francisco, California*. June.
- PRC Environmental Management, Inc. (PRC), LFR, and Uribe & Associates. 1997. *Parcel C Remedial Investigation Report, Hunters Point Shipyard, San Francisco, California*. Draft Final. March 13.
- San Francisco Office of Community Investment and Infrastructure (OCII). 2018. *Redevelopment Plan for the Hunters Point Shipyard Project Area*. July 16 (Amendment to July 14, 1997 plan and August 3, 2010 and June 22, 2017 amendments).
- SulTech. 2008. *Feasibility Study Report for Parcel C, Hunters Point Shipyard, San Francisco, California*. Final. July 31.
- Tetra Tech EC, Inc. (TtEC). 2008. *Radiological Addendum to the Revised Feasibility Study Report for Parcel C, Hunters Point Shipyard, San Francisco, California*. Final. June 20.
- TtEC. 2016. *Parcel C Radiological Construction Summary Report, Radiological Remediation and Support, Hunters Point Naval Shipyard, San Francisco, California*. June.
- TtEC. 2017a. *Final Status Survey Report, Building 224, Parcel C Phase III, Radiological Remediation and Support, Hunters Point Naval Shipyard, San Francisco, California*. February.
- TtEC. 2017b. *Radiological Construction Summary Report, Parcel C Phase II Project Area, Hunters Point Naval Shipyard, San Francisco, California*. Internal Draft. November.
- TtEC. 2017c. *Remedial Action Completion Report for the Durable Covers Remedy in Parcel C, Hunters Point Naval Shipyard, San Francisco, California*. Final. April.
- Trevet-Bay West JV LLC (TRBW). 2020a. *Technical Memorandum Optimization of the Management and Monitoring Approach Sampling and Analysis Plan for Basewide Groundwater Monitoring Program, Hunters Point Naval Shipyard, San Francisco, California*. Final. March 1.
- TRBW. 2020b. *2019 Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California*. Final. June.
- TRBW. 2020c. *Summary of July through December 2019 Semiannual Groundwater Monitoring Data and Exceedances in Groundwater, Hunters Point Naval Shipyard, San Francisco, California*. Final. May 1.
- TRBW. 2021. *Summary of January through June 2021 Semiannual Groundwater Monitoring Data and Exceedances in Groundwater, Hunters Point Naval Shipyard, San Francisco, California*. August 31.
- TRBW. 2022a. *2020 Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California*. Final. January.

TRBW. 2022b. *2021 Basewide Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California*. Final. August.

TRBW. 2023. *2022 Basewide Annual Groundwater Monitoring Report, Hunters Point Naval Shipyard, San Francisco, California*. Final. December.

United States Environmental Protection Agency (USEPA). 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final))*. EPA/540/R/99/005. July.

USEPA. 2011. *Exposure Factors Handbook: 2011 Edition*. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F. September.

USEPA. 2014. *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, OSWER Directive 9200.1-120, February 6.

USEPA. 2022a. *Preliminary Remediation Goals (PRG) for Radionuclides Calculator*.

USEPA. 2022b. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. November.

USEPA. 2023. *National Recommended Water Quality Criteria (NRWQC) for Priority Pollutants*. <https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table>.

USEPA and Regional Water Board. 2021. Letter from Karen Ueno (USEPA Region 9) and Jeff White (San Francisco Regional Water Quality Control Board), July 30, 2021. Subject: United States Environmental Protection Agency and San Francisco Bay Regional Water Quality Control Board Position Regarding Discontinued Monitoring of 21 Groundwater Wells and Closure of 2 Associated Plumes, Parcel C, Hunters Point Naval Shipyard, San Francisco.

Table 4-1. Parcel C and UC-2 Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	ROD Remediation Goal (2008) ^a	Source of Remediation Goal	Parcel
Soil (mg/kg)	Residential	1,2-Dichloroethane	0.28	RBC	C
		1,4-Dichlorobenzene	2	RBC	C
		2-Methylnaphthalene	150	RBC	C
		3,3'-Dichlorobenzidine	1.6	PQL	C
		Antimony	10	RBC	C
		Aroclor-1254	0.093	RBC	C
		Aroclor-1260	0.21	RBC	C
		Arsenic	11.1	HPAL	C, UC-2
		Benzene	0.18	RBC	C
		Benzo(a)anthracene	0.37	RBC	C
		Benzo(a)pyrene	0.33	PQL	C
		Benzo(b)fluoranthene	0.34	RBC	C
		Benzo(k)fluoranthene	0.34	RBC	C
		bis(2-Ethylhexyl)phthalate	1.1	RBC	C
		Cadmium	3.5	RBC	C
		Chrysene	3.3	RBC	C
		Copper	160	RBC	C
		Dibenz(a,h)anthracene	0.33	PQL	C
		Dieldrin	0.003	PQL	C
		gamma-BHC (Lindane)	0.0026	RBC	C
		Heptachlor epoxide	0.002	PQL	C
		Hexachlorobenzene	0.33	PQL	C
		Indeno(1,2,3-cd)pyrene	0.35	RBC	C
		Iron	58,000	HPAL	C
		Lead	155	RBC	C
		Manganese	1,431	HPAL	C, UC-2
		Mercury	2.28	HPAL	C
		Naphthalene	1.7	RBC	C
		Nickel	2,650	HPAL	C
		n-Nitroso-di-n-propylamine	0.33	PQL	C
		Organic Lead	0.5	PQL	C
		Tetrachloroethene	0.48	RBC	C
		Thallium	5	RBC	C
		Trichloroethene	2.9	RBC	C
		Vanadium	117	HPAL	C
		Vinyl chloride	0.024	RBC	C
		Zinc	370	RBC	C
	Industrial	1,4-Dichlorobenzene	4.5	RBC	C
		Aroclor-1260	1	RBC	C
		Arsenic	11.1	HPAL	C
		Benzene	0.39	RBC	C
		Benzo(a)anthracene	1.8	RBC	C
		Benzo(a)pyrene	0.33	PQL	C
		Benzo(b)fluoranthene	1.8	RBC	C
		Benzo(k)fluoranthene	1.8	RBC	C
		Chrysene	18	RBC	C
		Dibenz(a,h)anthracene	0.33	PQL	C
		Indeno(1,2,3-cd)pyrene	1.8	RBC	C
		Lead	800	RBC	C
		Organic Lead	0.5	PQL	C
		Tetrachloroethene	1.5	RBC	C
		Trichloroethene	6.6	RBC	C
		Vinyl chloride	0.055	RBC	C

Table 4-1. Parcel C and UC-2 Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	ROD Remediation Goal (2008) ^a	Source of Remediation Goal	Parcel
Soil (mg/kg)	Recreational	Arsenic	11.1	HPAL	C
		Benzo(a)pyrene	0.33	PQL	C
		Lead	155	RBC	C
	Construction	Aroclor-1260	2.1	RBC	C
		Arsenic	11.1	HPAL	C, UC-2
		Benzo(a)anthracene	6.5	RBC	C
		Benzo(a)pyrene	0.65	RBC	C
		Benzo(b)fluoranthene	6.5	RBC	C
		Benzo(k)fluoranthene	6.5	RBC	C
		Dibenz(a,h)anthracene	1.1	RBC	C
		Indeno(1,2,3-cd)pyrene	6.5	RBC	C
		Lead	800	RBC	C
		Manganese	6,900	RBC	C, UC-2
		Organic Lead	0.5	PQL	C
		Thallium	20	RBC	C
A-Aquifer (µg/L)	Residential - Vapor Intrusion	1,1,2,2-Tetrachloroethane	3	RBC	C
		1,1,2-Trichloroethane	4	RBC	C
		1,1-Dichloroethane	6.5	RBC	C
		1,2,3-Trichloropropane	0.5	PQL	C
		1,2,4-Trimethylbenzene	25	RBC	C
		1,2-Dichlorobenzene	2,600	RBC	C
		1,2-Dichloroethane	2.3	RBC	C
		1,2-Dichloroethene (Total)	210	RBC	C
		1,2-Dichloropropane	1.1	RBC	C
		1,3,5-Trimethylbenzene	19	RBC	C
		1,4-Dichlorobenzene	2.1	RBC	C
		Benzene	0.5	PQL	C
		Bromodichloromethane	1	RBC	C
		Carbon Tetrachloride	0.5	PQL	C, UC-2
		Chlorobenzene	390	RBC	C
		Chloroethane	6.5	RBC	C
		Chloroform	0.7	RBC	C, UC-2
		cis-1,2-Dichloroethene	210	RBC	C
		cis-1,3-Dichloropropene	0.5	PQL	C
		Dibromochloromethane	2.6	RBC	C
		Isopropylbenzene	7.8	RBC	C
		Methylene Chloride	27	RBC	C
		Naphthalene	3.6	RBC	C
		Tetrachloroethene	0.54	RBC	C
		trans-1,2-Dichloroethene	180	RBC	C
		trans-1,3-Dichloropropene	0.5	PQL	C
		Trichloroethene	2.9	RBC	C, UC-2
		Trichlorofluoromethane	180	RBC	C
		Vinyl Chloride	0.5	PQL	C
	Industrial- Vapor Intrusion	1,1,2,2-Tetrachloroethane	5.1	RBC	C
		1,1,2-Trichloroethane	6.7	RBC	C
		1,1-Dichloroethane	11	RBC	C
		1,2,3-Trichloropropane	0.5	PQL	C
		1,2,4-Trimethylbenzene	25	RBC	C
		1,2-Dichloroethane	3.9	RBC	C
		1,2-Dichloroethene (Total)	210	RBC	C
		1,2-Dichloropropane	1.8	RBC	C
		1,3,5-Trimethylbenzene	19	RBC	C
		1,4-Dichlorobenzene	3.6	RBC	C

Table 4-1. Parcel C and UC-2 Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	ROD Remediation Goal (2008) ^a	Source of Remediation Goal	Parcel
A-Aquifer (µg/L)	Industrial- Vapor Intrusion	Benzene	0.63	RBC	C
		Bromodichloromethane	1.7	RBC	C
		Carbon Tetrachloride	0.5	PQL	C
		Chlorobenzene	390	RBC	C
		Chloroform	1.2	RBC	C
		cis-1,2-Dichloroethene	210	RBC	C
		cis-1,3-Dichloropropene	0.5	PQL	C
		Isopropylbenzene	7.8	RBC	C
		Methylene Chloride	46	RBC	C
		Naphthalene	6	RBC	C
		Tetrachloroethene	0.9	RBC	C
		trans-1,3-Dichloropropene	0.5	PQL	C
		Trichloroethene	4.8	RBC	C
		Trichlorofluoromethane	180	RBC	C
		Vinyl Chloride	0.5	PQL	C
	Construction Worker	1,1,2-Trichloroethane	40	RBC	C
		1,2,3-Trichloropropane	0.6	RBC	C
		1,2,4-Trichlorobenzene	41	RBC	C
		1,2,4-Trimethylbenzene	53	RBC	C
		1,2-Dichlorobenzene	1700	RBC	C
		1,2-Dichloroethane	22	RBC	C
		1,2-Dichloroethene (Total)	270	RBC	C
		1,2-Dichloropropane	30	RBC	C
		1,4-Dichlorobenzene	52	RBC	C
		Benzene	16	RBC	C
		Bromodichloromethane	19	RBC	C
		Carbon Tetrachloride	15	RBC	C, UC-2
		Chlorobenzene	450	RBC	C
		Chloroform	26	RBC	C
		cis-1,2-Dichloroethene	270	RBC	C
		Naphthalene	16	RBC	C
		Tetrachloroethene	18	RBC	C
		Trichloroethene	290	RBC	C
		Vinyl Chloride	5.4	RBC	C
		2,4-Dimethylphenol	9800	RBC	C
		2,4-Dinitrotoluene	180	RBC	C
		3,4-Dimethylphenol	700	RBC	C
		4-Methylphenol	3500	RBC	C
		Benzo(a)anthracene	0.67	RBC	C
		Benzo(a)pyrene	0.05	RBC	C
		Benzo(b)fluoranthene	0.45	RBC	C
		Benzo(k)fluoranthene	0.45	RBC	C
		Chrysene	6.7	RBC	C
		Pentachlorophenol	50	PQL	C
	Protection of the Environment ^b	Chromium VI	50	SWC	C
		Zinc	81	SWC	C

Table 4-1. Parcel C and UC-2 Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	ROD Remediation Goal (2008) ^a	Source of Remediation Goal	Parcel
B - Aquifer (RU-C5 Plume Only) (µg/L)	Residential - Domestic Use	Chromium VI	109	MCL	C
		Antimony	6	MCL	C
		Arsenic	10	MCL	C
		Iron	10,950	RBC	C
		Manganese	8,140	HPAL	C
		Thallium	2	MCL	C
		1,1-Dichloroethane	5	MCL	C
		1,2,4-Trichlorobenzene	70	MCL	C
		1,2,4-Trimethylbenzene	12	RBC	C
		1,2-Dichlorobenzene	600	MCL	C
		1,2-Dichloroethane	0.5	MCL	C
		1,2-Dichloroethene (Total)	6	MCL	C
		1,2-Dichloropropane	5	MCL	C
		1,3,5-Trimethylbenzene	12	RBC	C
		1,3-Dichlorobenzene	183	MCL	C
		1,4-Dichlorobenzene	5	MCL	C
		Benzene	1	MCL	C
	Residential - Domestic Use	Bromodichloromethane	80	MCL	C
		Chlorobenzene	70	MCL	C
		Chloroethane	4.6	MCL	C
		Chloroform	80	MCL	C
		cis-1,2-Dichloroethene	6	MCL	C
		Methylene Chloride	5	MCL	C
		Naphthalene	0.093	RBC	C
		Tetrachloroethene	5	MCL	C
		trans-1,2-Dichloroethene	10	MCL	C
		Trichloroethene	5	MCL	C
		Trichlorofluoromethane	1,288	RBC	C
		Vinyl Chloride	0.5	MCL	C
		2,4-Dimethylphenol	730	MCL	C
		2,4-Dinitrotoluene	10	MCL	C
		2-Methylnaphthalene	24	MCL	C
		2-Methylphenol	1,825	MCL	C
		4-Methylphenol	182	MCL	C
		Benzo(a)anthracene	0.2	MCL	C
		Benzo(a)pyrene	0.2	MCL	C
		Bis(2-ethylhexyl)phthalate	4	MCL	C
		Carbazole	10	MCL	C
		Chrysene	0.2	MCL	C
		Dibenzofuran	12	MCL	C
		Hexachloroethane	1.7	MCL	C
		Pentachlorophenol	1	MCL	C
		Aldrin	0.05	MCL	C
		alpha-BHC	1	MCL	C
		Dieldrin	0.02	MCL	C
		Heptachlor Epoxide	0.01	MCL	C

Table 4-1. Parcel C and UC-2 Chemicals of Concern and Remediation Goals

Exposure Medium	Exposure Scenario	Chemical of Concern	ROD Remediation Goal (2008) ^a	Source of Remediation Goal	Parcel
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Reference:

Navy. 2014. *Explanation of Significant Differences to the Final Record of Decision for Parcel C, Hunters Point Shipyard, San Francisco, California*. Final. October.

^a In cooperation with the FFA signatories, the Navy developed a revised tiered approach that reduces excavation of soil that will not pose an unacceptable risk to human health and the environment once the remedy is fully implemented. Application of tiered action levels for the excavation portion of the selected soil remedy resulted in changes to the specific numerical RGs identified in the ROD as summarized in Table 4-1 of the ESD (Navy, 2014).

^b Protection of the environment protects or minimizes discharge that would be above the specified remediation goals; specific trigger levels are developed for each plume. Groundwater remediation goals for chromium VI and zinc are at the point of discharge to the bay.

µg/L = microgram(s) per liter

BHC = benzene hexachloride

ESD = Explanation of Significant Differences

FFA = Federal Facilities Agreement

HPAL = Hunters Point Ambient Level

MCL = maximum contaminant level

mg/kg = milligram(s) per liter

Navy = Department of the Navy

PQL = practical quantitation limit

RBC = risk-based concentration

RG = remediation goal

ROD = Record of Decision

SWC = Surface Water Criteria

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Table 4-2. Parcels C and UC-2 Remediation Goals for Radionuclides

Radionuclide	Surfaces (dpm/100cm ²)		Soil ^c (pCi/g)	Water ^e (pCi/L)	Parcel
	Equipment, Waste ^a	Structures ^b			
Cesium-137	5,000	5,000	0.113	119	C, UC-2
Cobalt-60	5,000	5,000	0.0361	100	C
Plutonium-239	100	100	2.59	15	C
Radium-226	100	100	1 ^d	5	C, UC-2
Strontium-90	1,000	1,000	0.331	8	C, UC-2
Thorium-232	1,000	37	1.69	15	C

Source of Goals:

Department of the Navy (Navy). 2006. *Base-wide Radiological Removal Action, Action Memorandum – Revision 2006, Hunters Point Shipyard, San Francisco, California*. Final. April 21.

United States Environmental Protection Agency (USEPA). 2000. *Radionuclides Notice of Data Availability Technical Support Document*. Targeting and Analysis Branch, Standards and Risk Management Division, Office of Groundwater and Drinking Water. March.

^a Based on "AEC Regulatory Guide 1.86" (1974). Goals for removable surface activity are 20 percent of these values.

^b Goals are based on 25 millirem per year (USEPA does not believe this NRC regulation is protective of human health and the environment, and the HPNS cleanup goals are more protective. This regulation is an ARAR only for radiologically impacted sites that are undergoing TCRAs and any additional remedial action required for those sites. It is not an ARAR for radiologically impacted portions of IR Sites 7 and 18 that will be transferred with engineering and institutional controls for radiological contaminants.)

^c USEPA PRGs for two future use scenarios.

^d Goal is 1 pCi/g above background per agreement with USEPA.

^e Release criteria for water were derived from *Radionuclides Notice of Data Availability Technical Document* (USEPA, 2000) by comparing the limits from two criteria and using the most conservative value.

AEC = Atomic Energy Commission

ARAR = applicable or relevant and appropriate requirement

cm² = square centimeter(s)

dpm = disintegration(s) per minute

HPNS = Hunters Point Naval Shipyard

NRC = Nuclear Regulatory Commission

pCi/g = picocurie(s) per gram

pCi/L = picocurie(s) per liter

PRG = preliminary remediation goal

TCRA = time-critical removal action

USEPA = United States Environmental Protection Agency

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